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Engineering Library

March 31, 1927

Engineering News-Record

Fort Snelling-Mendota Bridge Across the Minnesota River

...“And Far Away”: The observations of a civil engineer’s wife— Concrete Arch Bridge over the Minnesota River—Los Angeles Plant Disposes of Non-Combustible Rubbish—Waterproofing the Upstream Face of the Mountain Dell Dam

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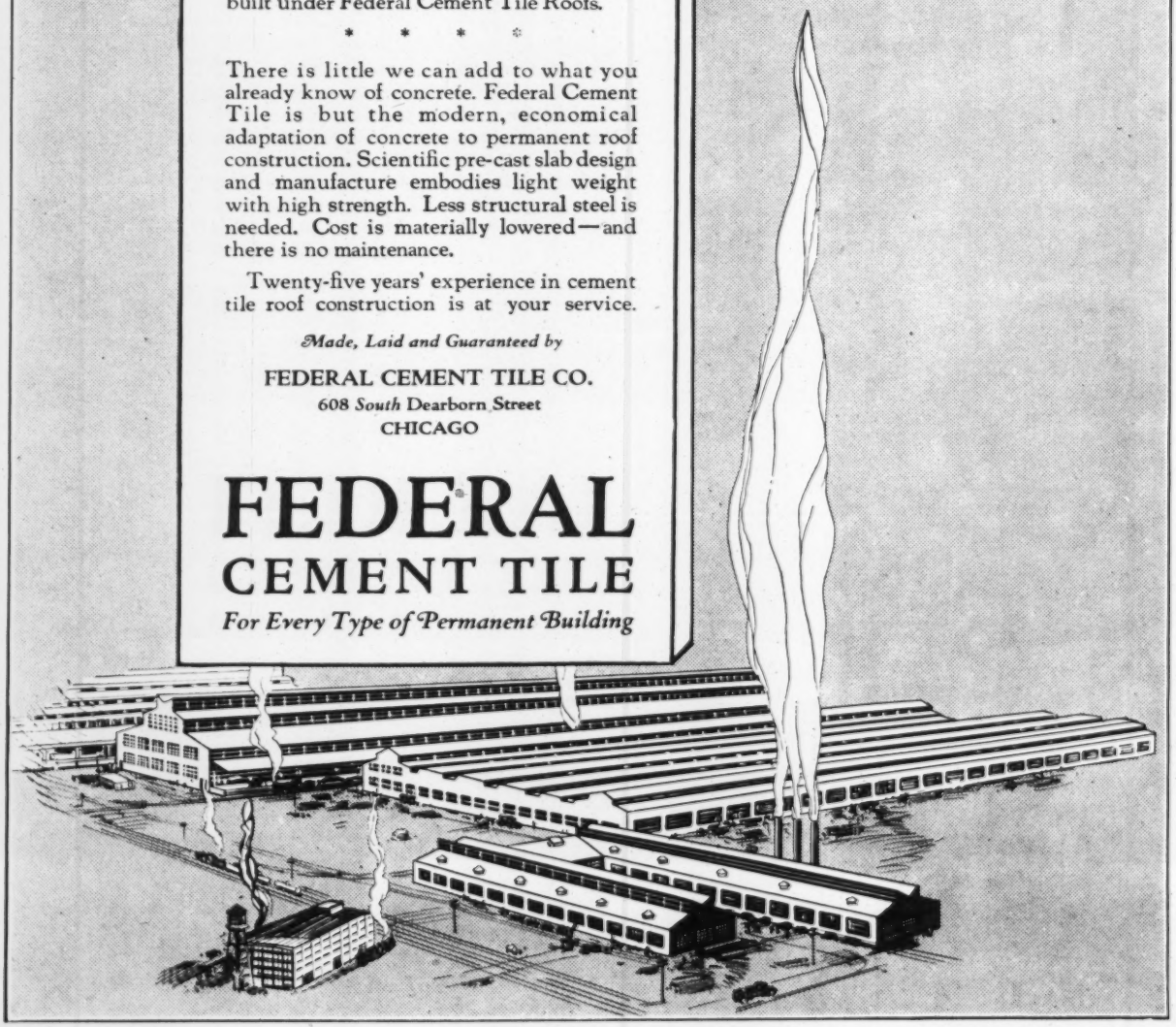

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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JAMES H. McGRAW, *President*
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FRANK C. WIGHT
Editor

Volume 98 NEW YORK, MARCH 31, 1927 Number 13

The Wife of the Nomad

ENGINEERS' wives are like their husbands—they are not very articulate. For that reason the reflections of the anonymous lady on another page are doubly interesting. They are the rare expression of what so many women have only felt. The lure of the job, the urge to be up and away on a new problem when the old begins to near solution, the charm of the unexpected and the unknown—these are of the essence of engineering, so whosoever would pursue it must have something of the nomad in his blood. But the women folk are nomads only by association. For them to find joy in a fugitive hearthstone and happiness in pastures new is a triumph of love, tempered with duty, over the inner urge for stability of home and friends. To all engineers who are on the march, who are now pausing at some dam or bridge or tunnel—and to their wives—we commend this revelation of what one woman thinks and feels.

Concerted Action in Fire Prevention

THE prevention of fire is partly an engineering and partly a social problem. Effective structural design and layout and proper signaling and fire fighting machinery can reduce both the chance of fire starting and of its becoming destructive, but beyond that there must be built up a collective social appreciation that destructive fire can be prevented, or at least reduced, by intelligent building and by personal carefulness. Various agencies, notably the National Fire Protection Association, have for years been engaged in spreading this gospel. They have had some success but they have not succeeded in reducing the total fire toll. More intensive effort is needed, particularly in the study of local conditions and emphasis on the lessons that are thereby learned. This intensive study is to be supplied by the campaign just launched by a national group of business men, as noted in our news columns this week. The campaign planned is rational, in that it starts with an engineering study of special localities and carries through by co-operation with the local agencies in getting to the public the facts and lessons of the survey. It is national only in the utilization of the experts who study the problem and in the force behind the drive. The movement deserves the support of every one who pays fire insurance, directly or indirectly, for only by reducing risk can rates be reduced and lives and property saved.

Business Worth Proper Direction

AMONG other harbingers of spring comes the annual estimate by the Bureau of Public Roads of new construction and probable total road expenditures by states during the current year. The detail figures are given in the news pages and here we need only remark their significance. In round numbers the total expenditures will aggregate over eleven hundred million dollars. This maintains the billion dollars a year mark which has come to be named the measure of America's highway business. Indeed in the last two calendar years the measure has been over-run by upwards of a quarter of a billion dollars and this year it would be no surprise to see actual expenditures increase the estimate by a couple of hundred million. These are rather stupendous sums. Indeed we have become accustomed in recent years to counting in such great numbers that we overlook how stupendous the sum of road work really is. It would be well if engineers and highway officials widely would make more effort to force fuller consciousness of magnitudes onto the people. They need to be made aware of the aggregates in money which they are entrusting to be spent for them and so be convinced of the importance of selecting capable agents and maintaining constancy of organizations to carry on their highway construction and upkeep. The legislatures of this winter have displayed scant recognition of the fact that permanency and personnel of state road organizations and officials should be any more than casual hazards of changing political administrations.

Dreams and Engineers

IT is a too common belief that engineers are not dreamers. Nothing could be further from the truth. Every engineering structure is a dream realized, a vision converted into steel and stone and concrete. Engineers are dreamers who make their dreams come true. At least they make some of them come true, which is more than can be said for the regularly acclaimed dreamers, the artists and the poets and the seers. More than that every engineer worthy of the name has some pet dream he plays with and works over with an intensity deserving fulfillment, and if any criticism lies against him it is that in the devotion to the elementary bases of his dream plans he sometimes forgets just the thing an engineer should always remember, that practical possibilities of fulfillment are very remote. These remarks are occasioned by a new West Side plan for New York City announced this week in the New York newspapers. It is only one more of the dozens that reputable engineers have proposed in the past twenty years. Structurally it is entirely feasible, mechanically it would undoubtedly work, but the governing fact remains that it would cost nearly a billion dollars, that to be workable it would have to be undertaken as an entirety, and that to put it into effect would require an immediate and entire revision of the political and economic structure and thought of the Metropolitan community. And yet its proposer has letters from eminent engineers saying that "the scheme is entirely feasible from an engineering point of view." What these gentlemen mean is that

the scheme could be put through were there no human obstacles, that given despotic power one could actually build the continuous superstreet with its homes and stores, its highways, freight terminals and moving sidewalks, and that once built it would pay on the investment. They do not mean that it is really feasible, because they know how insuperable would be the difficulties of getting the many interests involved to agree to the plan and then to finance it. To call such a scheme "feasible from an engineering point of view" is to forget the essence of engineering, that is to get the thing done. And so long as engineers forget that they will remain artisans, or dreamers.

Time Limits for Speakers

EVERYONE knows that the average engineering convention suffers from too much formal talk and too little informal discussion. One reason for this is that the formal talkers take up too much time—more than they are allotted almost without exception—so that the floor must needs remain silent or else go without meals or sleep. One way to relieve that situation would be to force the formal speaker to keep within his time limit. But as the current flapper says "Try and do it." They did try last month at a prominent technical convention. At the start of the convention the chairman displayed a nice little rig on his table with a yellow light to indicate a minute to go and a red one for "stop," and solemnly warned all speakers that for the protection of the floor the chair would have to insist that the speakers watch the signal and abide by its orders. And then through eight sessions over three days that ingenious device sat silent and dark on the chairman's desk while speaker after speaker calmly forgot the proscriptions of time limit to which he had agreed and while chairman after chairman allowed his innate sense of courtesy to overbalance his intention to give the audience a fair deal. What we need are a few hard boiled chairmen.

Politics in Control

SINCE the editorial in these columns last week on Governor Smith's proposed Power Authority the New Jersey legislature has given testimony to the dangerous implications of the Authority idea. For some reason, possibly political, possibly to defend a home industry, the legislature without discussion and with no notice to the other state in the bi-state compact passed an act vesting control of all Port Authority contracts in the executive heads of the State of New Jersey. In all probability the law will not stand even though the governor has approved it, but the gesture remains to indicate how frail is the contention that these Authorities will operate with the efficiency of private corporations. It is stated, with some degree of credibility, that the legislature has been moved to this action because there seemed to be danger that the new Hudson River bridge might be built of eye-bar chains, which probably would come from Pennsylvania, instead of the cables which a New Jersey mill would stand a good chance of getting. The new law would permit a group of non-technical elected officers of the state to decide this important question and to decide it, as the action of the legislature obviously forebodes, not on its technical features but on its local connotations or political suggestiveness. Thus this or any other of the details that make for safety on this largest bridge ever built would become the football of politics, although—and here is the gravamen of the charge—*the state assumes no responsibility for the security of the funds that are borrowed to build the bridge.* The same possibilities of political interference lie in any of these Authorities. If we want public ownership let us take with it all of its responsibilities.

Painted Locomotives

LOCOMOTIVES in olive green with structural lines picked out in red and gold are to signalize the passenger service of the railway which a few weeks ago celebrated the centenary of its charter. And too, the engines will have polished side and connecting rods and other shiny parts. But beyond all they will have names emblazoned in gold letters on cab-sides and front ends. So returneth the old order. When this writer first knew locomotives in a New England country village so long ago that the B. & O. had not yet celebrated the half-century anniversary of its charter, they were just such things of visual splendor as will be the 20 new passenger engines which the pioneer of American railways is now having delivered to it. And then the "diamond" stack disappeared and the big wood sheds south of the village were torn down and on the cabs numbers took the place of names and the engines which the boy had known by whistle-tone and name became bigger and bleaker and more powerful and altered beyond all comparison into moguls and mastodons and consolidateds and finally sunk to that nadir of individualization represented by hyphenated numerals. Therefore one old technical editor amidst the smiles of a lot of young ones greets the "innovation" of the Baltimore & Ohio's painted locomotives.

Who Are "Motorists?"

UPWARDS of four hundred and fifty million dollars were paid for road improvement in 1926 by motor vehicle owners, in special taxes—registration fees and gasoline taxes. The gross income from the two sources was $475,885,783, of which over thirty millions were diverted to other purposes, including collection costs. These sums include only state taxes. There were also federal taxes and various municipal taxes which the motor vehicle owner had to pay, but they all did not go into road improvement. No complete analysis will be attempted. Interest for the moment lies in the gross figures. To give motor vehicle owners all credit due them, a half-billion dollars may be estimated as their special tax contribution annually to highway improvement. This is an immense amount of money. But road improvements last year cost a billion and a third dollars, and this year the total is not likely to be less. Thus the citizen in his character other than a motor vehicle user is paying eight dollars for roads every time he pays five dollars as a motor vehicle user. Even on the basis which automobile club officials are fond of assuming that motorists are something distinct from the bulk of the citizenry, the "citizen" is paying more than the "motorist" for road service. The fact is, of course, that the motorist and the citizen are identical individuals. There is no considerable number of people—motorists—being burdened with special taxes for the benefit of a considerable number of other people—not motorists—who do not

pay such taxes. It is important to keep these broad truths and comparative totals of expenditure in mind when considering the large figures of gas tax and registration fee income, and also when the automobile club propaganda gets too insistent as to the rights and privileges of the "motorist."

Iron or Steel Turbine Runners

HYDRAULIC turbine runners were at first altogether made of cast iron but as heads increased and the strength of the runner section had to be increased to meet them cast steel has been substituted in a number of wheels. Both materials have their proper fields but a survey of runner troubles suggests that possibly not enough significance has been attached to the balancing of first cost against outage losses in the determination of the material for runners. Unfortunately, the inducement of lower first cost often overshadows other considerations when new plants are being designed, and sometimes even the recommendations of the designing engineer are overlooked on the strength of claims supporting a low bid made under stress of keen competition.

Generally speaking, cast-iron runners cost about one-third as much as cast steel. For low-head service where the vanes are thick, cast-iron runners at 1926 prices cost somewhere around 10 to 12c. per pound, or 18 to 20c. per pound for higher heads, say 120 to 150 ft., which involve thinner vanes, less total weight and greater danger of having to make a recast due to shrinkage cracks. Cast steel, on the other hand, would cost 30 to 35c. per pound in a unit designed for low heads where the runner weight might amount to 15,000 to 20,000 lb. The cost would range up to somewhere about 65c. per pound for high heads where the casting weight might be as low as 5,000 to 6,000 lb.

These costs per pound will vary, of course, but the relatively lower cost of cast iron will always obtain because iron casting is a simple process as compared to casting steel. For cast iron, the melting point is lower, molds are more easily prepared, no annealing is done (cannot be done, in fact, for the reheating would drive off carbon and thus make the metal more brittle than before) and finally less time and care is required in cooling to prevent shrinkage stresses. The internal stresses inherent in cast-iron runners greatly increase the risk as the head increases and the vanes become thinner. Since these internal stresses set up as the casting cools cannot be relieved by annealing, they must continue throughout the life of the casting, thus constituting an ever-present menace of cracking under sudden shocks or long-continued vibration.

On the basis of first cost alone the field of the cast-iron runner might seem to range up to moderately high heads. In fact, cast-iron runners have recently been built for unusually high heads. This saving in first cost, however, is made at the risk of lost revenue due to outage for repairs or replacement that is very large by comparison with the difference in cost between cast-iron and cast-steel runners. For example, a typical 20,000-hp. runner generates energy worth $1,200 per day net. It would take six days to dismantle this unit and about the same time for reassembly. Thus, even assuming that a spare runner was on hand, the lost revenue during the 12 days required for replacement would amount to $14,400. Taking the minimum price difference between cast iron and cast steel, the additional outlay necessary to secure a cast-steel runner in the first place would have been only $3,000, a "saving" that is wiped out by the revenue loss of a 2½-day shutdown.

Cast-iron runners have their field but it is poor economy to employ them where the water pressure is such as (1) to necessitate comparatively thin vanes cast in one piece with a thick hub, thus involving great danger of excessive internal stresses, or, (2) to impose unduly high unit stresses with the attendant possibility of shocks or vibration on thin vanes. Disregard of these considerations has been the cause of costly trouble which strongly emphasizes the economy of the somewhat larger initial cost of cast steel after passing the safe limits for cast iron.

News Versus Opinion

IT IS the custom of societies to place in a prominent position in their printed proceedings some such notice as this: "The society is not responsible as a body for the opinions and statements advanced in this publication." Periodicals do not go to such lengths to avoid responsibility, mainly because such a statement will not remove responsibility, either as to fact or opinion, when the article is unsigned, and will not remove legal responsibility if by chance a signed article is libelous. Nevertheless there are certain distinctions between opinion and fact in the columns of any well run journal which sometimes are not understood. Charles A. Dana once told an indignant correspondent that anything that the good God allowed to happen was fit subject for the columns of the *Sun*. Whether the editor believed that the happening was unfortunate or ill-advised or one which he, if permitted deistic control, would not have allowed was beside the point. It happened—and therefore the *Sun* reported it. It is obvious that an editor would have difficulty in maintaining this viewpoint. Some things do happen that no one writes about. But by and large the Dana principle is a good one. News is what occurs and the reporting of news is the reporting of what occurs.

In the mass of many things that occur there are only some that are of interest to the reader and editorial judgment must be exercised in their selection. But beyond that the editor can not pass judgment on the propriety of the happening. To refuse to print the news of something that happened and is known to a number of people because that happening may have an adverse effect on certain people is to fail in the true reportorial function. This is an elementary statement of a journalistic axiom but apparently all readers do not understand it. They confuse a news report with editorial comment and sometimes believe that because a paper reports some one as saying something that editorial assent is given to what is said, that because certain devices fail, to report that failure is to condemn the device. The news lies in the fact and if the fact exists the news must be reported. Opinion as to that fact is never properly given in the report but is left for inclusion in another part of the paper where the responsibility of the editor is clearly evident. If the reader of news keeps this distinction in mind he will never be misled by a news report.

Long Concrete-Arch Road Bridge Over Minnesota River

Thirteen Two-Rib Spans Carry Highway 120 Ft. Above Water—Steel Centers—Caissons Sunk 55 to 90 Ft. by Dredging—Grouting Foundation — Design and Construction Features

By Walter H. Wheeler
Designing and Consulting Engineer, Minneapolis, Minn.

THE Fort Snelling-Mendota bridge and the new highways which connect it with important centers and with the main trunk highways of Minnesota constitute a major highway development and one of the most important links in a system of paved highways having Minneapolis and St. Paul as its center. This bridge shortens the distance between Minneapolis and points south and east of Minneapolis by about five miles and correspondingly shortens the distance for through traffic on some of the heavily traveled trunk highways. By avoiding congested districts it reduces running time about half an hour.

This bridge was financed by Hennepin County. Before engaging to undertake the engineering of this project for the county, the writer stipulated that the county board should agree to keep politics and individual interests out of it and allow the engineer a free hand to secure the desired results at the least cost and with the maximum efficiency. It is to the credit of the board that it quickly agreed to that program.

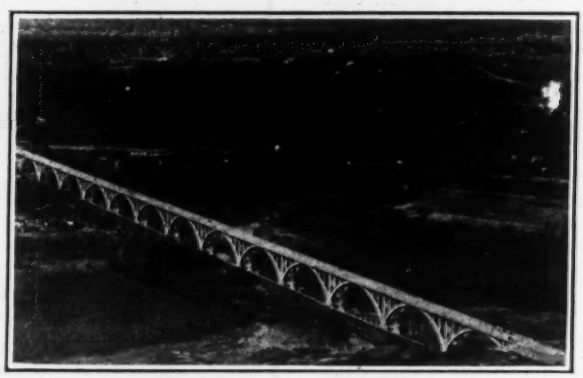


FIG. 1—FORT SNELLING-MENDOTA BRIDGE

Fig. 1 is a general view of the completed bridge and Fig. 2 shows the completed ribs of one span on the steel centers. Fig. 3 shows further details of the completed structure.

Geological and Topographical Conditions—According to the geologists, the Minnesota River meanders through a gorge cut by a great glacial river, known as River Warren, of which the Mississippi River was a branch. The Falls of St. Anthony, at Minneapolis, were cut back along this river to the confluence of the Warren and the Mississippi, thence up the Mississippi to their present location and up River Warren about 2½ miles, leaving a gorge some 200 ft. deep. A later ice flow ground off the layer of shale which overlay the surrounding country rock and filled the gorge with glacial mud to a depth of 70 to 80 ft. The old gorge in the vicinity of Fort Snelling is from 4,000 to 5,000 ft. wide, while the main channel of the Minnesota River is 300 to 400 ft. wide and 10 to 40 ft. deep. On both sides of the channel are lakes and marshes. At times of extreme high water the low lands are covered with 4 to 6 ft. of water for practically the full width of the old gorge.

Test drilling showed that the foundation conditions in the gorge are substantially the same at all points below the old falls, namely, 70 to 80 ft. of mud over sandstone or limestone bedrock, with a few feet of sand and gravel on top of the bedrock in some places. At the mouth of the Minnesota this condition changes and more gravel and boulders are found. The banks of the old river rise abruptly on each side of the gorge. There is a capping of about 20 ft. of Trenton limestone on top of 160 to 170 ft. of soft St. Peter sandstone; below is hard Shakopee limestone. The sandstone becomes quite hard near the contact with the limestone and some of the sandstone remains in places overlying the limestone at the bottom of the old gorge. In excavating one caisson a section of a vertebra was brought up from 60 ft. down in the mud which was identified as that of a pre-glacial buffalo.

As the Minnesota River is considered by the War Department to be a navigable stream, the same clearance for navigation is required as on the Mississippi River. The Chicago, St. Paul, Minneapolis & Omaha line of the Chicago & Northwestern Ry. is at the foot of the bluff on the Mendota side of the river. The Chicago, Milwaukee & St. Paul R.R. crosses the Minnesota on a swing bridge and has another line on top of the bluff on the Mendota side. The Fort Snelling military reservation is on the Minneapolis side, and the War Department would only permit crossing the reservation with a road at certain points, complicating the bridge location problem.

Bridge Location and Type—Four locations were made for a low-level bridge with draw span and long grades on fills and trestles up the bluff on either side of the river, and two locations for a high-level bridge. It was desired to eliminate all grade crossings and also the draw span if possible. Due to the foundation conditions and other limiting factors it was found that while a high-level bridge would be somewhat more expensive in first cost, the lower upkeep and its greater value to the users of the highway by eliminating grades and curves and shortening distances made it the best investment for the county.

On the ngineer's recommendation, the county first adopted the high-level bridge on location No. 1, because the length of bridge was about 100 ft. less than on No. 2 and the bridge would cost $50,000 to $100,000 less. Serious complications, which seemed insurmountable, developed in securing right-of-way, and on the recommendation of the engineer the county board then adopted location No. 2, some 400 ft. upstream.

Four types of design were considered: (1) Reinforced-concrete rib arches on concrete piers with caisson foundations; (2) steel arches with concrete piers and caisson foundations; (3) steel deck trusses on concrete piers and caisson foundations; (4) steel deck trusses on steel towers with pile foundations. The estimated cost of the various designs was in the order

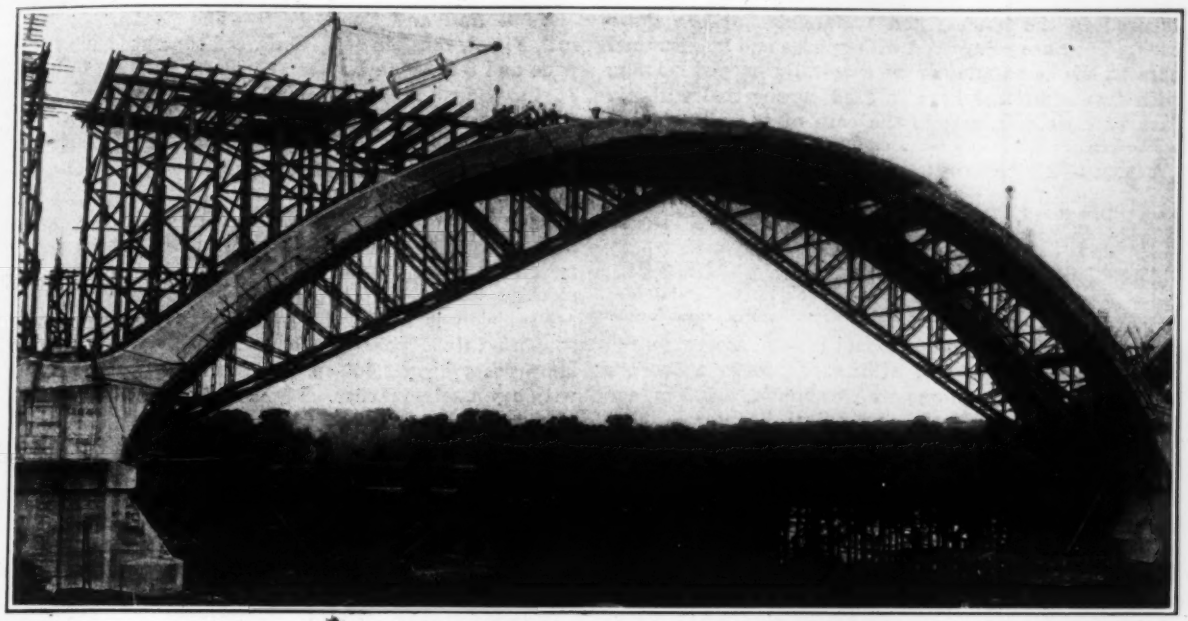


FIG. 2—COMPLETED ARCH RIBS ON STEEL CENTERS

given, type 1 being the most expensive. After going into the matter very fully the engineer recommended type 3, but because of the strong preference of the board for a concrete bridge he agreed to prepare working plans and specifications and to receive bids for types 1 and 3.

Bids were received in February, 1924. The low bid on the reinforced-concrete arch bridge, complete, was $1,870,000, with 30 months for construction. The lowest formal bid on the steel bridge complete with buckle plate floor, was $1,766,000; and 22 months time. An alternate bid on the steel design, with I-beam and concrete slab floor, was $1,713,807, with 28 months time, but this bid was informal and could not be considered.

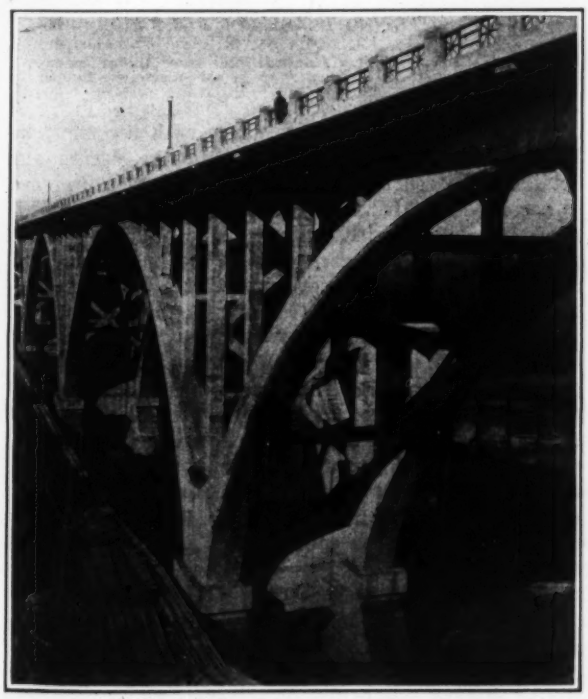


FIG. 3—PORTION OF FINISHED BRIDGE
Sidewalks cantilevered over arch ribs. Metal parapet between concrete posts. Construction trestle at left.

The engineer had estimated difference in cost between the steel bridge and reinforced-concrete bridge at approximately $250,000, but the only two bids for the steel bridge complete were disappointing, while the concrete bridge was preferred by the county board. After carefully weighing the various phases of the problem, the low bid on the concrete bridge was accepted. The contract was executed in February, 1924, and the date of completion was fixed at Sept. 26, 1926.

Description of Structure—The bridge is 4,066 ft. long between abutments, or 4,119 ft. including the end abutments. It has a roadway 45 ft. wide between steel-nosed curbs 11 in. high, with a 6-ft. sidewalk on each side, the width overall being 60 ft. 8 in. The roadway is paved for 41 ft. with 2 in. of asphaltic concrete, while concrete gutters 2 ft. wide, have 4-in. drains spaced 30 ft. 6 in. c. to c. Provision is made in the floor for a future double-track street car line. The roadway is designed to carry 25-ton tractors and the sidewalk for 100-lb. live-load.

The superstructure consists of twelve two-rib arch spans 304 ft. c. to c. of piers (283 ft. 4 in. clear), one three-fourths arch span at the Mendota end and five trestle spans at the Fort Snelling end. The floor is of flat-slab construction reinforced four ways, with depressed panels and bracketed column capitals. The columns are supported on the arch ribs. Expansion joints are provided in the floor of the bridge at each end abutment and over all piers, except piers 5 and 17, and are covered by double steel angles. Over the piers at expansion joints are double columns and double sets of sway bracing. Over the end piers are single columns with single sway bracing. Between arch ribs are struts located at points of column support.

In section, the arch ribs are square at the crown,

tapered to the haunch and rectangular at the skewback. They are reinforced with spirals and longitudinal bars in the same manner as a spirally hooped column, with two additional bars in each corner tied with tie bars at close intervals to the core of the rib. These

TABLE I—RECORD OF CENTERING: FORT SNELLING-MENDOTA BRIDGE

Span	Date Raised	Date Struck	Span	Date Raised	Date Struck
16–17	5/21/25	9/30/25	10–11	4/21/26	6/29/26
15–16	6/25/25	11/19/25	9–10	5/19/26	7/22/26
14–15	9/ 8/25	1/ 6/26	8– 9	6/14/26	8/12/26
13–14	10/28/25	4/12/26	7– 9	7/ 8/26	9/ 1/26
12–13	12/ 7/25	5/10/26	6– 7	7/29/26	9/27/26
11–12	2/ 1/26	6/ 5/26	5– 6	8/19/26	10/11/26

corner bars supply the additional tension steel required during construction, and afterwards serve as corner reinforcing. The columns which support the floor are reinforced with verticals and spiral hooping, except over the piers. Pier columns which are rectangular instead of square are reinforced with verticals and ties. The corners of arch ribs and columns are chamfered. Octagonal struts between the piers are reinforced with longitudinal bars and spiral hooping.

Abutments are of the hollow box type, and the end piers of the two end arches are built into the rock in the sides of the gorge. Twelve of the piers of the main arches are each supported on four cylindrical caissons sunk to bedrock at 55 ft. to 90 ft. and averaging about 70 ft. below the surface of ground or water. The shoe of each caisson, of reinforced concrete built into a structural steel frame, is 22 ft. in diameter and 11 ft. high, with a steel cutting edge. At the top of the

TABLE II—ARCH DEFLECTIONS: FORT SNELLING-MENDOTA BRIDGE

Span	Deflection At Crown — Center Line, Ft.	Deflection At Crown — Edge of Sidewalk, Ft.	Deflection At ¼-Point — Center Line, Ft.	Deflection At ¼-Point — Edge of Sidewalk, Ft.	Date
	A. Deflections when centers were struck				
17–18	—.040	.....	.....	.....	8/ 3/25
16–17	—.031	.....	+.005	.....	9/30/25
15–16	—.021	.....	+.006	.....	11/19/25
14–15	—.01	.....	+.005	.....	1/ 6/26
13–14	—.034	.....	.00	.....	4/12/26
12–13	—.008	.....	—.003	.....	5/10/26
11–12	—.008	.....	.00	.....	6/ 5/26
10–11	—.015	—.017	—.003	—.003	6/29/26
9–10	—.013	—.012	—.002	—.002	7/22/26
8/ 9	—.011	—.013	—.006	—.006	8/12/26
7– 8	—.012	—.012	.00	—.003	9/ 1/26
6– 7	—.011	—.011	.00	.00	9/27/26
5– 6	—.009	—.009	.00	.00	10/11/26
	B. Deflections During Lowering of Centers				
17–18	Centers of this span not lowered from deck				.....
16–17	—.01	.....	.00	.....	10/ 5/25
15–16	—.01	.....	.00	.....	11/20/25
14–15	—.01	.....	+.001	.....	1/14/26
13–14	—.005	.....	.00	.....	4/14/26
12–13	—.008	.....	+.002	.....	5/11/26
11–12	—.007	.....	.00	.....	6/ 7/26
10–11	—.011	—.011	—.002	—.002	6/30/26
9–10	—.002	—.007	.00	.00	7/23/26
8– 9	—.005	—.007	.00	.00	8/13/26
7– 8	—.007	—.007	.00	.00	9/ 4/26
6– 7	—.008	—.008	+.002	+.002	9/29/26
5– 6	—.008	—.007	+.002	+001	10/13/26

shoe there is a 4-ft. offset made in two stages to the barrel of the caisson cylinder, which is 14 ft. in outside diameter. The shells of the caissons were built up in sections 5 ft. and 10 ft. high and 2 ft. thick, leaving a 10-ft. shaft through which the dredging was done. After sinking, the caissons were sealed with rich concrete and filled with 1:3:5 concrete in which rubble stone was embedded.

All piers except the end piers are designed to permit construction of the bridge with three sets of centers and to take the unbalanced loads of construction with that system of centering. The end piers are designed as abutment piers.

Hand Rail and Lamp Posts—The parapet or hand rail, Fig. 3, consists of a reinforced-concrete curb 10 in. wide and 8 in. high between concrete posts 51 in. high, 36 in. wide and 14 in. thick, paneled on both sides. The end posts and posts supporting lamp standards are 4½ ft. wide. Between posts, the rail is 3 ft. 3 in. high and consists of built-up steel panels with top member of 4-in. steel pipe having the ends let into cast-iron flanges in the concrete posts, but left free for expansion and contraction movements. Cast steel panels bolted to the pipe and to the curb are connected by steel angles.

Provision is made in posts at suitable intervals to support future poles for a street railway. Cast-iron lamp posts have 1,000-cp. lamps in ripple-glass globes with asymmetric domes. Lighting is controlled by time clocks and also by a key switch at each light. Electric conduit to supply the lights is carried in the sidewalk slab under the hand rails. Two 4-in. fiber conduits for telephone wires, with one 3-cell and one 6-cell tile conduit are buried in one sidewalk, with manholes at intervals. One 6-cell tile conduit is buried in the opposite sidewalk, with provision for installing manholes when required.

Materials and Construction—The steel centers for the

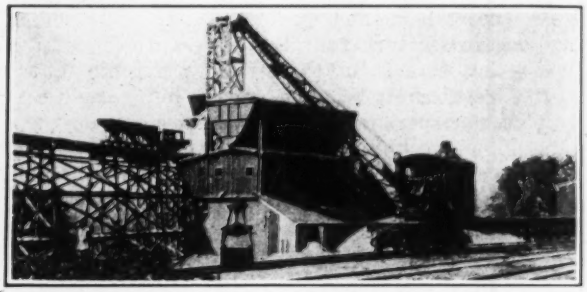


FIG. 4—CONCRETING PLANT FOR FORT SNELLING-MENDOTA BRIDGE

Cement shed at right. Material bins over mixer house. Elevator bucket delivers concrete to side-discharge hopper cars.

arches were designed in accordance with recommendations of the engineer, who checked the design and details. The concrete mixing plant was also designed in accordance with his requirements and subject to his approval. The engineer furnished center line, grade and bench marks at each end of the bridge and the contractor laid out his work from these points.

A minimum mix of 1:2:4, using gravel or crushed rock, was specified, except for the caisson filling and the hand railing. Control of water ratio and a minimum strength of 2,400 lb. per sq.in. on concrete test cylinders at the age of 28 days were also specified. The sizing and quality of aggregates were particularly specified, including hardness, toughness and water absorption for the coarse aggregate, thus eliminating materials known to disintegrate rapidly by frost action and weathering. The specifications also provided that sand and gravel must be washed and that if crushed rock was used it must be free from dust. Gravel aggregate was used throughout, with the exception of a small amount of caisson concrete made with crushed rock. Structural and intermediate grades of steel were used for all reinforcing, including spirals. All vertical surfaces of the concrete above ground level were ground dry with carborundum stones by electrically driven

machines, except that the hand-rail posts were rubbed with carborundum blocks and water.

The concreting plant, Fig. 4, was set up at the Mendota end of the bridge and a railroad yard built from a spur of the C., M. & St. P. R.R. at the top of the bluff. At the foot of the bluff, the C., St. P., M. & O. R.R. had a passing track which the contractor arranged to use for unloading and loading equipment and materials and to which the working trestle was connected by a switch which permitted the locomotive cranes to operate on this passing track when necessary. A cement shed with capacity for several thousand barrels was served by a belt conveyor which delivered the cement sacks to the charging floor. Four steel storage bins for fine and coarse aggregates, with batchers, were above the mixer hoppers.

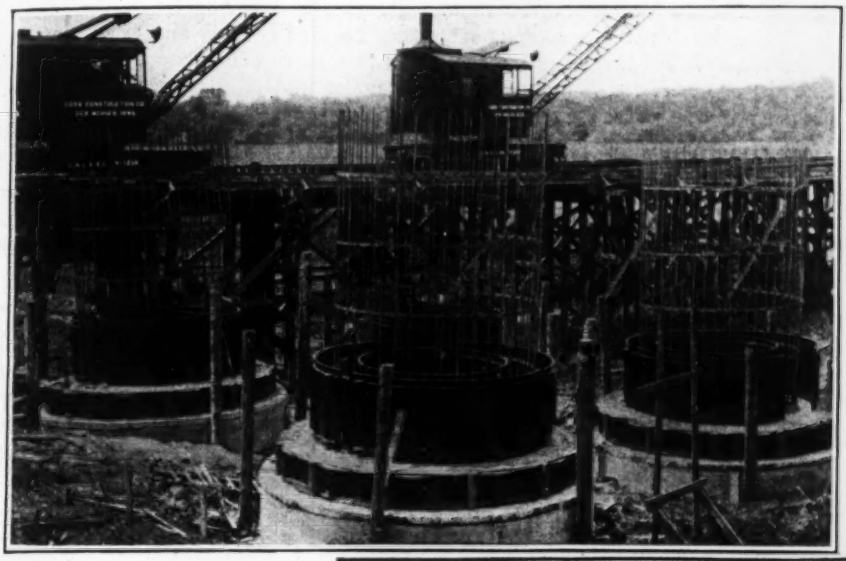


FIG. 5—(ABOVE) SINKING PIER CAISSONS
Locomotive cranes on construction trestle handled grab buckets, placed steel forms and poured concrete.

FIG. 6—(BELOW) CONCRETING THE FLOOR SLAB
Wood chute with drop pipes delivers concrete in place. Note heavy reinforcement.

Two ¾-yd. mixers driven by electric motors dumped into metal-lined wood spouts arranged to discharge into a hoisting bucket to deliver the concrete to a steel hopper. This hopper discharged to side-dump cars on an elevated track and also into a steel chute which delivered the concrete to a large steel hopper set over an industrial track below to discharge into bottom-dump cars. This track was laid out on the working trestle beside the standard-gage track on which the cranes operated. All concrete, except that used in columns and floor slab, was hauled out on the lower track in trains of four to six cars by gasoline locomotives and was deposited by locomotive cranes. On the upper track, the concrete was hauled in trains of three and four cars by gasoline locomotives and dumped into wooden chutes which delivered the concrete in place.

Concreting—During construction of the arch ribs, the order of pouring concrete on each pier was checked by the contractor's engineer and by the bridge engineer. The same order of pouring the sections of each arch rib was maintained throughout and at least 48 hours elapsed after all other concrete was poured before the key sections were poured. The arch rings were poured in nine sections, including key sections. The floor was poured in alternate sections. Fig. 6 shows the floor reinforcement and concreting chute with drop pipes.

Sand inundators were installed in 1925, although good and uniform concrete had been secured previously by careful handling. The total amount of water in the concrete per sack of cement ranged from 6½ to 6¾ gal. This was reduced to 6¼ gal. after the inundators were installed, without decreasing the workability of the mix, while a more uniform consistency was obtained. The strength of concrete, as determined by 28-day test cylinders 6x12 in. had an extreme range of 2,413 to 2,825 lb. per sq.in. for all cylinders taken before installing the inundators. Those taken with the inundators in use showed higher strength, ranging from 2,672 to 3,521 lb.

Work on the piers progressed continuously through the winter of 1924-25, the water and aggregates being heated so that the concrete reached the forms at 100 to 110 deg. F. The fresh concrete was enclosed in canvas and kept warm by salamanders under this covering. In the winter of 1925-26, work on the superstructure was stopped from Dec. 22 to March 3, but before closing down some of the work was done at temperatures ranging down to 10 deg. below zero, even lower tem-

peratures being reached while the concrete was still green. Here the arch ribs were enclosed in canvas and the floor in board sheds and canvas, and the concrete was kept warm for a week after pouring. No difficulty was experienced in keeping the concrete warm and no concrete was frozen. These precautions for cold weather work were provided for in the specifications.

Construction was begun at the Mendota end, but the abutment and trestle at the Fort Snelling end were constructed separately during the progress of the work. The working trestle 4,000 ft. long was of standard railroad type, 20 ft. above low-water level, built along one side of the bridge. Piles 70 ft. long were required. For the bents opposite the piers, where the cranes worked while sinking the caissons, the piles were driven flush and capped at the ground or water line to carry

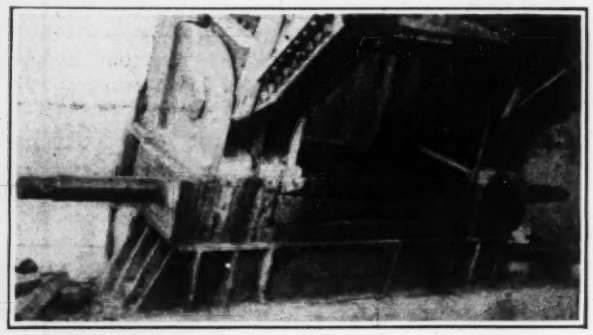


FIG. 7—WEDGES FOR LOWERING ARCH CENTERS

trestle bents. Work was carried on at several piers at one time. Four locomotive cranes were employed, one unloading sand and gravel and other material in the yard at the top of the bluff to keep the aggregate bins above the mixing plant filled, and the other three cranes on the foundation work; when that was completed, one crane was released while the others finished the work.

Caisson Work—Preliminary soundings showed the bedrock to be nearly level across the full width of the gorge, sloping slightly at the two caisson piers nearest each end. At pier 12, one caisson landed in a pothole in the rock with the edge of the caisson toward the Fort Snelling end resting on the sloping side of the hole. Prospecting with a drill showed that the pothole was filled with sand and gravel and was only 6 or 7 ft. below the bottom of the caisson. To use compressed air and cut out a seat in the rock for the caisson would have been expensive. The writer decided to try grouting the sand and gravel in the pothole, and prepared a sketch of the grouting machine from which it was built by the contractor. This machine was tested first in similar material to see what penetration could be expected (illustrated in *Engineering News-Record* Oct. 14, 1926, p. 621).

Five grout pipes were sunk to bedrock and grouting begun early in the morning was carried on until the work was complete, the pipes being pulled gradually as grouting progressed. This work was done under 90 ft. of water. After the grout had set, drill holes showed that the grouting had succeeded. The total cost of the operation was less than $3,000, as compared with an estimated cost of $30,000 to $35,000 with air locks.

Caissons were required to be centered correctly and plumb within 9 in. and these requirements were closely adhered to. One caisson slipped out of plumb about 3 ft. when it had nearly reached bedrock, due to too rapid digging on the inside, but was forced into place by using hydraulic jacks against the thick ice and jetting on the opposite side. The pressure applied was about 300 tons and the caisson was straightened up in a few days. It was possible to unwater a number of the caissons after they reached bedrock and clean them by hand, after which they were allowed to fill with water and were sealed under water. The majority of the caissons could not be unwatered. These were cleaned by jetting and inspected by a diver who also assisted in the final cleaning up.

Steel Arch Centers—Handling the steel centers, Fig. 2, was one of the problems of the work which the contractor solved very well. As described in *Engineering News-Record*, Oct. 14, 1926, p. 621, the centers were assembled in a horizontal position in four sections on skids; then the wind bracing was put in and the centers were raised in two halves, each half weighing about 205 tons. The forms for the center three panels of the floor in each span were supported on I-beams which in turn were carried on the steel centers. The rest of the floor forms were supported on bents from the arch ribs and steel I-beams across these bents.

The time of striking the steel centers was determined by the age and hardness of the concrete in the three middle spans of the floor, since the forms for this part of the floor were necessarily struck with the steel centers. The dates on which centers were raised and struck for each span are given in Table I. This omits the first or three-fourths arch span, as its centers had to be erected on falsework and taken apart for removing. As centers were removed they were shifted ahead three spans and raised again, until the last span was reached. Fig. 7 shows the steel wedges and shoes, with operating screws, for striking the centers.

As the arch centers were struck and lowered, readings were taken of the deflections in the arch ribs and floor, as given in Table II. A minus reading is a deflection downward and a plus reading is a deflection upward. In lowering the centers, the load of the free ends of the centers and of the lowering machinery, or a total of about 210 tons, was carried on the floor of the bridge at the middle of the arch span.

When the centers were struck, the floor had not been poured on the whole of the span. In some cases two panels were not poured on each half of the arch span. This condition produced tension on the top of the arch rib at the quarter point and a slight rise at the quarter points resulted when centers were struck. On other spans only one floor panel on each half of the arch span remained to be poured but the resulting tension did not produce a rise at the arch rib quarter point.

General Information—Remarkably fast progress was made on the construction of the superstructure during the spring and summer of 1926. Centers for an entire span on the last four or five spans of the bridge were struck, lowered, moved ahead 900 ft. and raised again in 5½ to 6 days. Only about 3½ weeks was required to strike, lower, move and raise centers, build forms and pour concrete for each of the last six spans, including arch ribs and floor complete for a 304-ft. span. During the summer of 1926 the concrete mix for 90 ft. of floor at the crown, which was supported on forms from arch centers, was changed by the contractor to 1:1¾:3½ in order to shorten the time the forms were left in place,

with the result that test cylinders showed that forms could be removed in 12 to 13 instead of 16 to 17 days.

Fire and tornado insurance was carried by the county on completed work and on materials which had been delivered to the site and paid for in monthly estimates, and the contractor was required to carry insurance on his equipment and forms.

The approach roads were completed in 1926, so that when the bridge was ready to open to traffic on Nov. 8, 1926, the entire project was complete. The bridge was dedicated to the 151st Field Artillery, U. S. A. In all, twelve contracts were let on the entire project, all to the low bidder on first advertisement.

Engineers and Contractors—Walter H. Wheeler and the C. A. P. Turner Co., Associated, were designers and engineers of the bridge. M. G. Hyde was chief office engineer. F. A. Camp was resident engineer until January, 1926, when he asked to be relieved because of advancing years. W. C. Jorgenson was resident engineer for the rest of the job, and E. M. Beal was inspector. The Koss Construction Co., Des Moines, Iowa, had the general contract, with Frank Kratoska as general superintendent and William De Butts as engineer.

Power Requirements of Industrial Plants and Steel Mills

Use of Steam or Electric Power, Produced in Plant or Purchased, Depends Upon Economic Factors and Individual Plant Processes

ABSTRACTS of two of the papers read at the recent Midwest Power Conference in Chicago, relative to power requirements of industrial plants and steel mills follow:

Industrial Power Plants (By Samuel G. Neiler, consulting engineer, Chicago)—In relation to the development of industrial power plants it may be said that engineers thoroughly versed in individual branches such as construction, furnace design, heating or refrigeration may not be capable of visualizing and correlating all the items which enter into the engineering field of industrial work. It is only within the past few years that concentrated effort has been made to analyze plant conditions with the idea of increasing economy in production not only as to the power plant but, which is most important, in the manufacturing departments of the industry. Many advances have been made in the economical production of power, utilization of byproducts, higher machine speeds and improvements in handling and factory routing of manufactured products. A summary of some power-plant functions is:

Electricity: For light and power, ovens, laboratory heating units, welding.

Steam: For heating buildings or water; for dry kilns and process work.

Compressed Air: For drills and other tools or machines; hoists; oil or pulverized-coal furnaces; foundry molding machines and special equipment.

Water: For domestic and fire purposes and for process work; refrigerated water for drinking; high-pressure water for riveters and other machines.

Miscellaneous: Dust-collecting systems are required for foundries, wood-working mills and other industries. In foundries there is also sand handling and conditioning apparatus. In manufacturing plants, transportation methods have to be considered for handling materials and products, also arrangements for storage and shipping facilities.

The modern industrial plant of 2,500 to 20,000 kw. is almost invariably complicated on account of demands for steam in processes or for the utilization of by-products, so that the electric power becomes more or less of a by-product and in many cases is developed at a cost with which a service supply company cannot compete. The mere fact that a large central station develops electrical energy at a very low cost does not determine the decision in connection with an industrial plant. The only consideration is what advantage there is in purchased power as compared with the isolated plant. Mr. Low, past-president of the American Society of Mechanical Engineers, had an editorial in *Power* which was a plea for industrial power plants to keep up with modern development and to design for economy in fuel production.

Where there is any by-product, there is the chance for maximum return, and engineering along this line has progressed steadily. Thus cement plants utilize waste gases to generate sufficient steam to operate their entire electrical equipment and provide for compressed-air requirements, the kilns using no more coal than before, and coal for the boilers being used only after a shut-down for annual repairs. A decided advance has been made also in collecting and recovering cement dust that was formerly discharged into the atmosphere. As much as 13 tons per stack per day has been thus recovered. Marked development has been made in the economical burning of wood waste, from sawdust with 15 per cent moisture to kiln-dried lumber, and this has been due mainly to analysis of the various types of furnaces.

In foundry work, mechanical molding has resulted in a more uniform product at lower cost. A recent foundry of this type has a continuous uninterrupted production of one car-wheel per minute throughout the 8-hour day. In high-pressure hydraulic machinery the problem of interruptions due to breakage of supply lines to the valves on account of vibration has been solved by spiral pipe connections designed to suit the different sizes of pipes. In all such cases, the engineer must realize the necessity of analyzing every problem, as each problem distinctly stands by itself.

Power for Steel Mills (By Wilfred Sykes, consulting engineer, Inland Steel Co., Chicago)—Probably the most important item in the development of the steel industry has been the availability of power which can be substituted for human effort, giving increased production coupled with improved working conditions and standard of living. This has been accompanied usually by a reduction in cost and selling price of the product. Figures at one plant indicate an increase in production per man of about 35 per cent in the past ten years, in spite of the elimination of the 12-hour day.

At the present time the steel industry is largely electrified. This power is used even for driving the main rolls in a large proportion of the mills and is universal for auxiliary devices. Approximately 75 per cent of the power in 1926 was generated in the mills and 25 per cent supplied from outside sources, mainly central station plants. The aggregate rating of motors in steel mills is about 3,500,000 hp., of which 1,000,000 hp. are driven by purchased power. The largest continuously rated rolling-mill motor is 9,000 hp., but where several motors drive different units of the mill the total power may be much higher. Many of the continuously running mills have constant-speed motors, but there is increasing use of adjustable-speed motors.

A characteristic of steel-mill load is considerable fluctuation in the demand for power and little correlation between the operation of the blast furnace and the power requirement. The load factor on week days will average 60 to 65 per cent, based on the maximum load, or 45 to 50 per cent when spread over a year. This is not an ideal load for internal-combustion engines, which should be operated near their rated capacity and without rapid load changes. Where gas engines have been used, therefore it has become regular practice to install about 30 per cent of the total capacity in turbo-generators to carry the peak load and regulate the system. But the overall efficiency of such a combined plant is not much in excess of that of a turbo-generating plant, while in addition to its complications the former costs much more than an all-steam plant. With boilers heated by waste gas from the open-hearth furnaces, steam generated averages 1,200 to 1,500 lb. per ton of steel produced, and usually all the steam available is used.

Future development at steel plants having blast furnaces will be in installing steam turbo-blowers and turbo-generators and in connecting these plants with central station plants, so that excess power can be delivered to or additional power taken from the latter as conditions require. For steel plants which have no blast furnaces and have central-station power available it is better to purchase power.

"—AND FAR AWAY"

Being the Candid Observation of a Civil Engineer's Wife

IF it were only far away. If it were the scorching sun of the equator burning one's face, or the arid winds of the steppes whirling the permanent wave out of one's hair, or Mexican banditti racing through the camp at midnight, that disturbed one's dreams, one could bear it with fortitude. But the hot shadowless sun of our own west, nerve-wracking winds, the constant grit of blowing sand, the scrub pines, the rattlesnakes, the bunty scrambling prairie-dogs, are not essentially romantic. And instead of Mexican brigands we have 100 per cent American bootleggers, with their guarded automobiles swooping through the settlement in the small hours, the smooth put-put of the racing engines causing grizzled foremen and swarthy laborers and the mincing store-keeper-postmaster to turn over in their beds.

When Is an Engineer?

It is a curious but authentic fact that engineers figure in fiction as gallant, athletic long-limbed persons clad in flaring breeches and immaculately shining boots; they are found in vaguely designated tropical climes and go about rescuing Spanish maidens from their proper suitors and frustrating in the same breath and by prodigious muscular efforts certain greasy-faced revolutionists in the latter's attempts to dynamite the canal —or the bridge or the mine or whatever the author pleases. Following this truly remarkable display of agility it is presumable that the hero of the tale gives up engineering as his tender plans with the senorita invariably include such stable things as a permanent home and dwelling-place—usually with a sunken garden, a deep fireplace and a Russian wolfhound—to say nothing of various offspring—in perspective. Unfortunately for romance this is a vastly fallacious notion. The engineer, by the very nature of his thinking process, is not impulsive. He is deeply imaginative but never reckless. And his boots are usually anything but shining. And furthermore he is quite frequently already married before encountering the passionate-eyed senorita!

What successful engineer does not give a generous share of the credit for his success to his wife? Of course, this is true also of men of other professions but it seems to me that an engineer's wife thoroughly deserves all the credit that comes her way. Her ups and downs are so contrasted, they come with such breath-taking suddenness, they are apt to entail such cataclysmic adjustments. She must have a blue-steel soul and an India-rubber disposition.

Let no woman whose heartstrings are inextricably entangled around a hearthstone marry an engineer—unless indeed, it be a portable hearthstone. For even though she may remain here in our own land the changes are many and abrupt.

Concentrated Housekeeping

Every spring when my husband goes out in the field—and the full meaning of those words "out in the field" only the wife of an engineer can tell—he urges me to remain in the city, or to take refuge in my mother's home with its deeply upholstered chairs and soft rugs and regulated heat, to say nothing of its propinquity to doctors and theatres, libraries and clubs, ice and sterilized milk. It was only after my first season in the field that I recognized certain luxuries as luxuries. Before that I took such things for granted. Now I sink into a silky, cushioned easy-chair with a delicious relaxing of muscles, I pull the velvet cord of the lamp with a thrilled pleasure in the instant light that glows upon my page, I move the thermostat control up and down for the pure delight of so simply increasing the heat.

But every spring I negative my husband's unselfish suggestion. Our year divides itself into certain intervals.

Along in December the storms come and the work freezes up; the machinery and paraphernalia of construction are packed away or shipped out and one glorious day, before Christmas if we are lucky, we take train or boat or auto cityward.

My apartment-hunting period is of necessity limited. Usually one day must suffice. I grasp hastily at the first apartment that offers itself, always paying at least twice the rent I had intended. I leave my husband to grapple with the intricacies and difficulties of securing an optional lease—a process which mysteriously increases the landlord's honorarium as well as paying for the winter's coal of the renting-agent and a new fur coat for the janitor's wife. In the meantime I telephone feverishly to the storage house for my furniture and fly to the shops for new curtains. Gradually I am acquiring a collection of curtains large enough to curtain an orphan asylum.

Following the arrival of my household goods there are catastrophic discoveries. Anxiously I inspect the rent in the needlepoint upholstery of a beloved chair, a quarter-inch gouge on a shining panel of a precious gate-leg table, an inexplicably sagging spring of a davenport, the torn fringe of my one Oriental rug, the pitiful remains of a piece or two of my heirloom Haviland, and with incredulous ears I hear of the latest scale of prices set by the movers' union.

I plunge into an orgy of housekeeping. I wrangle with the grocer, the butcher, the milkman, the florist, for the pure joy of having a grocer, a milkman, a butcher, a florist with whom to wrangle. My remorseless dealings with the iceman are particularly delightful inasmuch as during the rest of the year while my grocer is canned, so to speak, my butcher glassed and my milkman tinned, the iceman is absolutely unrepresented in any shape or manner. I can think of nothing that would be more unobtainable than ice in the field.

I go on a T-bone steak spree. I debauch myself with movies, dancing and marcels. I wallow in the new novels, spending heedless hours wandering in the bookshops. I spend whole days in the fashion shops and buy to the limits of my purse clothes of the most seductive and delicate hues; gowns that I cannot take to the field but for which I have a ten-months-old hunger.

I intoxicate myself with the theatres; I revive my soul with symphony concerts; I store up energy and thrilling life from the pulsing crowds of people—people—people. And I go to church and renew my heart in the swelling tones of the organ—in the sight of the worn grandeur of the altar.

As for my husband, I daresay he conducts himself in much the same manner. At least I have known of long hours spent in luxuriating in the bath-room and of hilarious revivals of old fraternity associations.

In the Field

Then one day he comes home with a look in his face that I have come to recognize. In twenty-four hours, or thirty-six or seventy-two, he must be at some unheard of place upon the earth's surface. So far this has been within the United States, but even this boundary offers a wide limit. Between gasps of telephoning the movers, writing hurried notes and packing away my newly acquired clothing, we endeavor to discover the exact location of our destination. Occasionally this entails calling at the Post Office for assistance.

Before I am fully aware of it we are in the car, unless our journey is *too* long, and I am wondering if the light and gas are turned off and if I left a mailing address.

Strangely enough, the day on which we turn our faces toward the field is no less glorious than the day we start toward the city, our task for the year complete.

To be sure there are years in which I get no glimpse of my own loved household furnishings, and at one period for two whole years I lived within the same four walls, while the attention of the head of the house was engaged upon the construction of a viaduct. But I am always happy when the day comes to strike our tents and fare forth into the wilderness.

Ultimately we wind up at a settlement, sometimes a town of as many as two hundred souls, sometimes only a camp. The trail may lead in almost any direction toward the sand stretches of eastern Colorado, or the muddy cotton fields of Mississippi, or the neatly wooded slopes of Ohio with their criss-crossed rail fences, or toward that lovely langorous Bayou Têche country where the Spanish moss waves gray and wraithlike from the trees, the early japonica blooms scarlet and the creamy magnolias hang heavy with fragrance; it is there that the natives, and Ca'jens as the negroes have contracted the name Acadian, speak an odd and pretty French-Canadian patois.

Or perhaps the trail ends as it did a month or so ago, in the Nebraska Bad Lands. To the south are buttes rising like buttressed castles and canyons like sudden black gashes. On the north stretch the sandhills, dotted with sage-brush and yucca and tumble-weed that blows unceasingly. The arroyos grow delicately amethyst as the sun's shadows slant and a pink rim round the horizon, contrasting with the solid turquoise-blue of the sky, gives the first hint of the approaching of enchanted nights. Enchanted nights when the sky becomes deep sapphire before our very eyes and the stars glimmer like great yellow flowers so low as to be plucked. Last night the Northern Lights flung up long, cold white rays that flickered and danced like monstrous ghostly fingers pointing the way to Heaven—and the whole universe of suns and planets whirled so near I had almost thought to see the moons of Mars.

Indeed, it is well that we have those respites for there is much that is anything but beautiful.

As I wrestle with the devil-inspired whims of my stove, as I eat canned foods until my tongue has a perpetually *tinny* taste and ham and bacon until I wonder if my very insides are pickled in salt, as I cope with the demoniac antics of a small tin basin and recall the impeccable plumbing of my latest apartment—on these too frequent occasions I reflect that an engineer's wife must have an amazing amount of fortitude, a philosophical outlook and a sense of the ridiculous. I do not mean that a wide and toothy smile at every obstacle is to be desired. It is true that I have displayed my teeth at this stove but scarcely in a smile. I also find that a well-chosen word or two from the camp vocabulary will do much to relieve my feelings in times of stress.

The Portable Hearthstone

Nomads that we are for at least ten months out of the year, it is nevertheless a fact that after the first meal in our new abode—be it tent or cabin or where—an odd feeling of being at home pervades us. This is an elusive feeling, difficult to analyze and flees at the first mention of its being. But it returns.

True, there are certain bits of a household that always go with us—a funny old clock with a squeak in its in'ards—a battered and worn cribbage board—a squatty, gay little candlestick that has practical use—my own letter-case, a Navajo blanket and a paper-weight. This paper-weight is of no practical value. And yet it accompanies us. It is a crystal ball mounted upon a black base; inside the crystal rears a tiny castle with red towers and green stones under its bits of windows. You've seen them. As the weight is moved snow flies inside the crystal, swirling 'round and 'round until it finally settles in little drifts upon the castle and green rocks. I have come to the conclusion that the eddying whirls of snow exercise some occult influence upon my husband—at least I have watched him sit with the paper-weight in his hands, moving it, letting the snow settle slowly and then disturbing it again, his gaze abstracted, far-away, until suddenly he drops the weight and bends swiftly over his work as if to seize inspiration before it escapes him.

And speaking of his work: I would advise an engineer seeking a wife to choose one who has some understanding of the simpler forms of mathematics. Since the humiliating hour when my husband found that I cannot remember that seven times eight is sixty-three—or is it fifty-six—and that by preference I add with the assistance of my own ten fingers—since that humiliating hour he has never trusted me even so far as to check two rows of figures.

The Divine Flame

Pages galore have been written of the work that the doctor of medicine performs, of the wonderful hands of the surgeon; much has been said of the architect, the teacher, the minister of the gospel; more has been told of painters and poets and musicians. But comparatively little has been said of the engineer.

One reason for this, I fully believe, is that the engineer is not loquacious. In this age of confessions and self-advertising he has had few words to say for himself. He has ever let his proud title be stolen with impunity.

It is surprising, indeed it is appalling, to discover what the world at large thinks of an engineer. Of course to the lettered the title possesses its own honor-

able estate but to far too many it is a vague name that may mean anything. Not long ago a university woman asked me, "Just what does an engineer do—survey the roads or something?" And another, with the light of charity in her eye and the key of a scholarship fraternity upon her blouse, offered for my husband an old pair of overalls that she somehow possessed, mentioning at the same time that the bricks must hurt his hands. To the former I replied briefly, "Sometimes." To the latter, tersely, "No thanks." Experience has taught me the futility of explanation. To quote the subsequent remark of a garrulous landlady who succeeded in pinning me down to a résumé of the engineer's exact activities—"To hear her tell it, you'd think he runs the whole thing."

I do not mean to imply that these instances are wholly typical of the general attitude, but *where* would that one be found who would fail to recognize by name any of the other professions!

The engineer is an artist, a true artist who works for love of his work, who creates for the joy of his creation. Let my husband but hear of a new and stupendous project and a longing, eager gleam flares into his eyes as he murmurs, "Gosh, I would like to be on that job." And there is that in his tones that is fairly reverent.

Above my eyes is a picture cut from the rotogravure section of some newspaper and *glued* upon the wall. It is a photograph of a project of considerable magnitude, now completed, on which my husband was one of the least of the corps of engineers. It is scarcely decorative but my husband's hands placed it there with such care, I have seen his eyes upon it with such wistful joy in their depths, with such pride, with such glory in its completion that I could not think of removing it. And there it sticks—with my packing box desk below it.

Inevitably an engineer, unless impelled by the pressure of actual financial stress, will choose the project that stirs enthusiasm within his heart, rather than that one that brings him the most money. The monetary consideration seems to be the last. There have been many times when I have bit my lips to keep from saying, "But what about the salary" or share or investment or whatever it is. And there are few engineers' wives who will not bear me out in that statement.

For all his seeming literalness of mind the engineer holds in his heart the divine flame of imagination—and sometimes genius.

It is true that by the nature of his training and thinking habits he sticks to facts. There is no compromise. A thing is—or is not. Reason, logic, proof are the keynotes of his mental processes. His is one of the most exact of sciences. Where I leap to a conclusion my husband asks himself—Is this true? Why? Does it prove?—before his decision is made. And once made that decision is as firm as the concrete with which he deals. Which fact, I might add sometimes causes fur to fly!

The wife of an author of my acquaintance has told me of her efforts to keep things quiet while her husband works. Perhaps authors are a law unto themselves. This I know: I experience as great a difficulty in dragging my husband's attention up from the depths of thought into which he descends. But the papers covered with scrawled figures, the half-done sketches, the arrowed and lined and mysteriously dotted plans—all these I treasure as carefully and refrain from disturbing as my friend does her husband's most interlined sonnet.

To the engineer is the God-given privilege of transmuting the glowing vision he has dreamed into a permanent and lasting monument. A monument not to himself, not even to his profession but to the needs and progress of humanity.

"Green Mansions"

Well, we have high moments of joy—and we have also long days of problems that are solved only to make room for other problems, of the tension of a responsibility that never relaxes, and of hard, grinding, monotonous drudgery. I say "we," because the engineer's wife shares her husband's life and work no less than do the wives of men of other professions. And though that life may lead her to strange places it is one that may be lived with joyous fullness. It is a life of contrasts and of vivid and glowing contacts. From roaring city to bare and sand-swept desert—from the cosmopolitan and traveled rancher who has seen the frontier cities of every land to the provincial city-dweller who has never been beyond the limits of the elevated.

And it is a life that will take us, we hope, to far lands and strange countries and age-old cities—lands and countries and cities that though strange are nevertheless dear and familiar.

We treasure the memories accumulated here in America but there is a voice that urges us to go farther. It is the voice that calls to the explorer, the discoverer, the pioneer, the adventurer. Some engineers answer that call, some do not. "Chacun á son metiér!" But I have yet to hear of the engineer who was wholly deaf to that voice.

Evenings of hearing only the desert's "song of a thousand years," the low hushed murmur that never dies—long evenings of quiet that is punctuated only by the yowl of a coyote, the flicking of the sand against the house, the far-away thud of an engine racing on the road over the horizon—night after night of solitude such as this have led us to varied pursuits. The radio has been Heaven-sent. Our cribbage board, as I have said, is battered and worn. But our favorite and loved diversion is reading. What discussions we have engaged upon! What theories we have explored! What stars we have traced in their courses! And what travels we have taken via the printed page.

Of all these books one of our most favored is "Green Mansions," and somehow, in that irrational way that such customs grow, we have taken to calling our own hopes and dreams, our castles in Spain—Green Mansions.

Green Mansions mean to us many things, and all of them are magic. The green tangled forest growths of the tropics, the barren steppes surrounding Lhasa, the dirt and smells and narrow, mysterious streets of Cairotown, the muddy swelling currents of the Nile, the sordid rifled majesty of Petrograd, golden Samarkand, lovely Tahiti, and the Forbidden City with its ghosts of ladies clad in Imperial yellow and jade-buttoned emperors and wise and long-passed sages.

Names to conjure with, words to revere, phrases to stir within the heart strange feelings of kinship, of blood-ties, of haunting familiarity, of unutterable fascination and longing. All these things we must seek. All these things we must know. So runs the building of our Green Mansions. M. G. E.

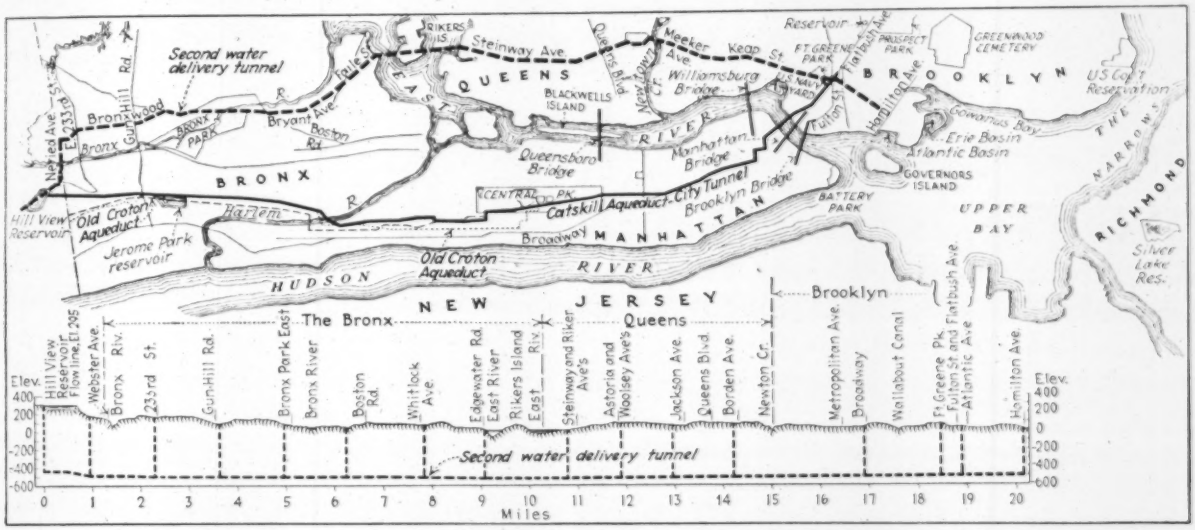
Second Deep Delivery Tunnel for Catskill Aqueduct Water

In Rock Over 500 Ft. Deep with 17-Ft. Diameter for Most of Its 20-Mile Length—$67,000,000 for 700-M.G.D. Capacity

THE SECOND pressure tunnel for delivering water from the Catskill aqueduct to the distribution system of New York City, recommended by the Board of Water Supply in December, 1924, but not approved by the Board of Estimate until March, 1927, will be 20.2 miles long, all in rock at a depth of 500 ft. or more below sea level. Like the existing delivery tunnel, the second one will start at the Hill View distributing reservoir, in the city of Yonkers, and end in Brooklyn Borough, but the routes of the two are quite different, as the accompanying map shows. The first delivery tunnel extended the length of Bronx and Manhattan Boroughs, well over toward the Hudson River, and crossed beneath the East River to Brooklyn north of the Manhattan and Brooklyn bridges. The new tunnel swings to the east on leaving the reservoir, then bears still farther eastward, crosses beneath the East River at Riker's Island, and then proceeds southerly through the length of Queens and Brooklyn Boroughs, bearing constantly to the west, after passing beneath Newtown Creek, until it connects with and passes beyond the first deep tunnel in South Brooklyn. In Queens and Brooklyn Boroughs the new tunnel is kept as far to the eastward as the rock formation permits. The new tunnel will have a clear diameter of 17 ft. from the Hill View reservoir to the point where it meets the old one, a distance of 18.9 miles; then it will be 15 ft. in diameter for its final 1.3 miles. The estimated cost of the 17-ft. tunnel is $2,950,000 a mile or $55,755,000 in all, and of the 15-ft., $2,600,000 a mile, or a total of $3,380,000. The remaining part of the $67,249,000 of total cost is made up of $2,000,000 for right-of-way and land shafts and $6,114,000 (10 per cent) for administration, engineering and contingencies. The right-of-way costs are relatively small, as 16 miles of the tunnel are beneath streets, parks and other city property, 0.8 miles under river and harbor waters and only 3.4 miles under private lands.

The carrying capacity of the new tunnel is figured as 700 m.g.d. to the intersection with the old one, which equals the estimated demand for the territory served up to 1950. The existing tunnel was put in use on Jan. 22, 1917. In 1924 (the year of the report recommending the new tunnel) the old tunnel carried as high as 500 m.g.d., its designed capacity.

When needed, the new tunnel can be carried beneath The Narrows to Richmond Borough (Staten Island), now served by submerged steel mains. Similarly, the new tunnel could be extended northerly from Hill View distributing reservoir to the Kensico storage reservoir, making "directly available," says the 1924 report of Thaddeus Merriman, chief engineer Board of Water Supply, "not only the large storage which it contains but also such additional pressure as its higher level will furnish."



PLAN AND PROFILE OF SECOND CATSKILL AQUEDUCT DELIVERY TUNNEL FOR NEW YORK CITY
The first delivery tunnel, in use since January, 1917, is shown between the new tunnel and the Hudson River.

Engineering News-Record is informed by Mr. Merriman that two contracts for test borings will soon be let for the purposes of final location and that this and other work of investigation and design will require some 9 to 12 months, after which contract plans and specifications will be made ready.

Backherms Author of Tunneling Article

The article on "Soft Ground Tunneling Methods for Small Sewer" that was published in *Engineering News-Record* in the issue of March 24, p. 478, was written by A. B. Backherms, who is resident engineer at the sewage treatment plant at Akron, Ohio. Inadvertently, in the makeup the author's name was omitted from this article, and credit is hereby given to Mr. Backherms for his description of the work and methods on this Akron sewer tunnel.

Travel Notes on Highway Building In French Algeria

High Type Concrete and Asphalt Pavement Found with Well-Kept Macadam Roads of 3,000-Mile National System

By W. W. Crosby
Consulting Engineer, Baltimore, Md.

ALGERIA has for years had the reputation of having excellent roads. A recent trip made by the writer through Scotland, England, France, Switzerland, Italy and to Algeria has indeed impressed him with the belief that the condition of Algerian roads was better than that of any others seen in his wanderings. It was the good fortune of the writer furthermore to make

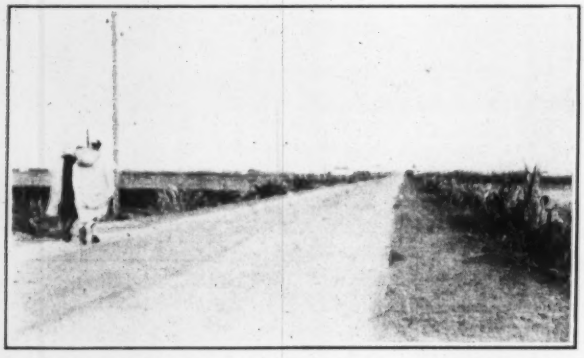


FIG. 1—NATIONAL ROAD, ALGIERS TO TUNIS, OF CEMENT-CONCRETE
This is a "soliditit concrete" pavement constructed in 1925 of Soliditit cement produced by the Société Anonyme des Ciments de Mons, France, and a specially graded aggregate; it is a proprietary construction.

his inspections of Algerian roads as the companion of Col. P. LeGavrian, head of the highway division of the French Ministry of Public Works at Paris, and as the guest of J. Vicaire, inspector-general of the Corps des Ponts et Chaussées for Algeria.

The French colony of Algeria has about 10,000 km. of public road, of which 5,000 km. are "routes nationales." The area of Algeria (185,000 sq.mi. exclusive of the Sahara) is about one-sixth greater than that of California. To one familiar with southern California, Algeria presents a very close similarity in natural appearance.

The road expenditures of Algeria are met entirely from the funds of the colony though the work is under the direction of the famous Corps des Ponts et Chaussées of France. Members of the corps are detailed for the Algerian work as local representatives there in charge. The local head of the corps in Algeria is Jules Vicaire, inspector-general, stationed at Algiers. Under him are the various division, district, and resident engineers, inspectors, etc. The inspector-general reports directly to the Governor of Algeria and also to the French minister of public works in Paris.

Prior to the war the national routes of Algeria were mainly of water-bound macadam fully up to the high standards of the French. Since the war and the installation of motor traffic, much of this old macadam has been treated or covered with bituminous surfacings of various kinds. Also some cement-concrete roadways have been laid along the heaviest traveled sections. All of this work of restoration or improvement seems to

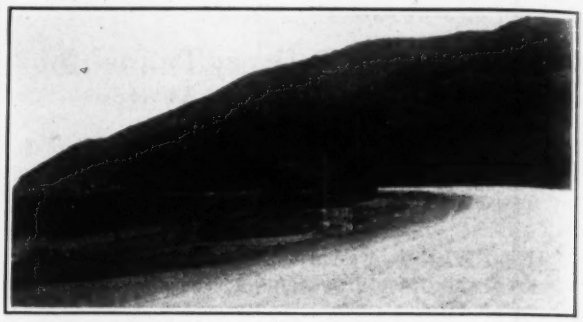


FIG. 2—WATER-BOUND MACADAM ROAD, ALGIERS TO SAHARA DESERT
This is a view in the picturesque Gorga du Chiffa.

have been of extraordinarily high character and to have given remarkably good results, including economy of costs and pleasingly successful surfaces for travel.

The utmost use of the original macadam in the new surfacings seems to have been made. For instance, a section of some six miles of excellent cement-concrete roadway—apparently equal in riding qualities to anything in the United States—was completed over a year ago on the main road between Algiers and Tunis. The concrete ("soliditit") was laid to a thickness of 3 in., and 20 ft. in width, over the old water-bound macadam, which originally was between 12 and 15 ft. wide. A necessity for keeping the route open to traffic compelled the construction of half the new roadway at a time with a center joint. Our inspection last November revealed an almost perfect condition. There were very few cracks to be found and those two or three observed seemed to be seasoning cracks.

Most of the restoration and modernizing of the old Algerian roads seems to have been along the lines of what we know as surface treatments. The use of an emulsified asphaltic oil preparation, known as Coulasse, and applied cold seems quite popular there. This or a similar preparation was formerly called Spra-mex. The results apparent on the roadways are extraordinarily good and indicate what skill and care may obtain in this work with economy of expenditure. But one comment or helpful suggestion occurred to the writer toward better results, and that was to use coarser grit for covering the oil in order to secure a more lasting surface as well as one less inclined toward slipperiness.

Some excellent penetration work has also been done in resurfacing some of the more heavily traveled sections of the routes. Bituminous mixtures have also been laid successfully.

FIG. 3—AN ALGERIAN ROAD BUILDING CREW PREPARING GRADE

FIG. 4—AN ORIENTAL IDEA OF SECTION WORK
Father sits in front holding the baby in his lap and limiting his labors to that and to smoking. At the right, mother is breaking rock when she is not nursing the little one while in the background there are two young boys also "napping" stone.

Sufficient time and funds since the war have not yet permitted the resurfacing of all the old water-bound macadam on the routes nationales of Algeria and stretches of it are still in evidence. The effort seems to be seriously made to preserve it in as good condition as possible and most of the results are admirable.

In all this work the French as usual set an example of care and skill which should be appreciated by highway engineers and contractors everywhere. Prior to the application of the surface treatment, the old water-bound macadam is perfected in a high degree. Depressions and unevennesses are not left to be remedied by the subsequent varnishing. The ultimate results therefore wear more uniformly and are easier of maintenance.

As usual in Europe, the use of block-paving is general on the streets of towns and cities of Algeria. And it is commonly found to be in good, smooth condition. Ordinarily these pavements are not laid on concrete but on gravel bases. The block pavement surfaces presented to traffic are generally more smooth and even in Europe than in America.

From Algiers, via Blida en route to the Sahara Desert, the routes southerly cross a low coastal range of hills and then a wide valley, flat and near sea level. Below Blida the route has to go over the main range of mountains (the Atlas) whose summits reach up to 7,500 ft. above the sea. The route southerly from Blida via the Gorge of the Chiffa is particularly picturesque besides being well surfaced. Some of this route is already surface treated. On the outlying sections water-bound macadam seems to meet the needs satisfactorily, and it was found to be in excellent condition.

FIG. 5—BLOCK PAVEMENT IN STREET OF BLIDA

It must not be inferred that the continued use of water-bound macadam and of surface treatments means that the traffic is wanting in weight or numbers. The visitor is impressed to the contrary. There seems to be a constant stream of traffic over these national routes, even at distances from the foci of population, and many more motor vehicles are in evidence than might at first be thought possible.

The mixed character of the traffic renders the problems of road construction and maintenance on the Algerian routes most difficult. This mixture consists of pedestrians, bicycles, motorcycles, burros, mules and saddle animals, with or without carts, ox teams, heavy freighting wagons, and motor cars, trucks, and buses. Some of the largest buses to be found anywhere run out of Algiers for long distances. Besides seats for from 25 to 35 persons inside, they carry benches on top for 20 to 30 more. They make good speed and are particularly well patronized by the natives.

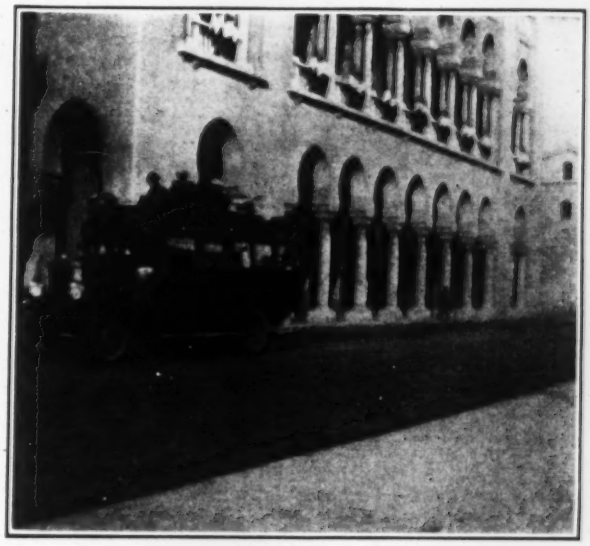


FIG. 6—AN INTERURBAN BUS PASSING CUSTOMS HOUSE IN ALGIERS

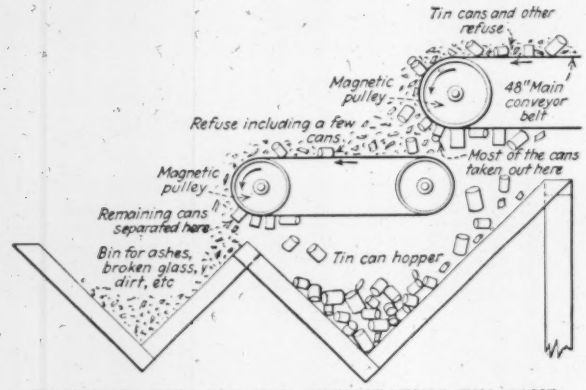
Canadian Railway Monopoly Opposed

In an address delivered in Toronto, Ontario, recently E. W. Beatty, president of the Canadian Pacific Ry., declared that he did not believe in a railway monopoly for the Dominion. He expressed the belief that a merger of the two great railways, such as has been advocated both in and out of Parliament lately, would involve difficulties of administration which would in time affect the character of the service given to the public, and that competition was necessary for the maintenance of efficiency. Mr. Beatty said the two systems were competing, and strongly competing, and the people of Canada were obtaining excellent transportation facilities and were being charged lower rates than were being charged in any other country in the world. The spur of competition was probably the finest asset in the Canadian railway service today, said Mr. Beatty.

Plant Disposes of Non-Combustible Rubbish at Los Angeles

Tin Cans, Scrap Metal and Bottles Bring Revenue—Presence of Combustibles Materially Increases Cost of Handling

SINCE 1910 there has been in effect in Los Angeles a municipal ordinance requiring each householder to keep two refuse cans and to segregate non-combustible rubbish from kitchen waste. The latter, which is defined in the ordinance as "garbage," is required to be free from paper or anything not food waste. It goes to the Fontana hog farm, the operation of which was described in *Engineering News-Record*, Aug. 6, 1925, p. 208. The domestic non-combustible rubbish is collected by the city and is sold to the Los Angeles By-Products Co. to whose plant in the southeast part of the city it has been delivered for some fourteen years. Commercial rubbish is not collected by the city and has to be disposed of by the firms producing it.


Tin cans and other refuse
Magnetic pulley
48"Main conveyor belt
Refuse including a few cans
Most of the cans taken out here
Magnetic pulley
Remaining cans separated here
Bin for ashes, broken glass, dirt, etc
Tin can hopper

MAGNETIC PULLEYS FOR SEGREGATING TIN CANS

Occasional extensions to and frequent rearrangement of the non-combustible disposal plant have been necessary to improve its efficiency and provide for the growth of the business. Because of the more or less experimental and varying nature of many phases of the plant operation it has not been advisable to make extensive or permanent installations. Fortunately, however, that is not essential to economical operation in a plant where the function is salvage by the hand-sorting process.

The first ten years of operation were carried on under two successive 5-year contracts, which provided that the company pay the city for the refuse delivered. In 1925 a 10-year contract was made under which the company was to pay the city $502 per month for the refuse. The quantity of combustible material admixed with the non-combustible causes difficulties in some new phases of the plant operations and as a result negotiations are now under way for a modification of the contract unless the city can more rigidly enforce the ordinance restricting the use of the rubbish can to non-combustibles.

In April, 1925, the Metals Refining Co. built a detinning plant alongside the By-Product Co.'s plant and has since then been taking the tin cans after these have been separated from all other rubbish. Prior to the advent of this detinning plant the solder was melted off and the cans were baled with scrap metal.

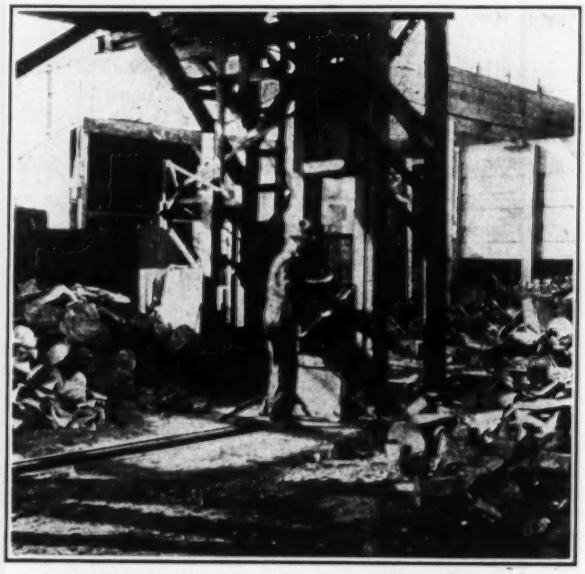
The vehicles used by the city in refuse collection are 2½-ton trucks having ordinary bodies of 10 cu.yd. capacity. At the plant, laborers shovel the refuse out the rear with scoop shovels. This is done on an elevated delivery platform reached by a ramp. The trucks back to the edge of the platform, which is 110 ft. long, below which is the storage pile serving the main conveyor belt.

The average delivery in a 26-working day month is 13,500 cu.yd. The quantity of each truckload is estimated and recorded by a city inspector. Collections for six months, according to city records, average 528 cu.yd. per working day. A maximum single day's collection in December last was 691 cu.yd. which included some back work accumulated during rainy weather, while the minimum day's collection—during stormy weather—was 332 cu.yd. It should be noted that collections are never omitted on account of weather. The low total for rainy weather is due to householders neglecting to set their cans at the curb.

Experience at the plant indicates that dump trucks would not be as desirable or economical in this service as would trucks with bodies that could be tilted or removed with a hoist. If the plant were to be rebuilt it is thought that the preferred arrangement at the dumping platform would be to have hoists or cranes to tilt the truck bodies into bins that would not allow the material to pile up at the edge of the platform.

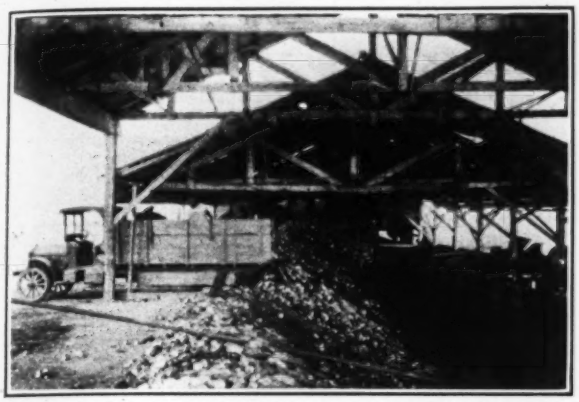
The tonnage of reclaimed materials from the monthly average of 13,500 cu.yd. averages as follows: 600 tons of tin cans; 175 tons miscellaneous metal ("riffraff") that is cleaned by burning lightly in the yard to remove combustible material and then compressed into bales; 15,000 salable bottles; 85 tons of salable broken glass; 1½ tons of rags and 8½ tons of scrap metal, tires, rubber, and other miscellaneous material salable as junk. A check on one day showed a list of 167 combustible items observed in the refuse. These included a variety of discarded articles ranging from wooden washing machines to boudoir caps.

The dumping platform is set back about 24 ft. from the main conveyor belt and is 13 ft. above it, this space constituting a storage capacity of some 800 cu.yd. from which the material is raked or is moved with scoop shov-



DROP HAMMER BALING BLACK METAL

Workman is loading compartment under the hammer. Material at right has been through the fire. Storage pile in background.



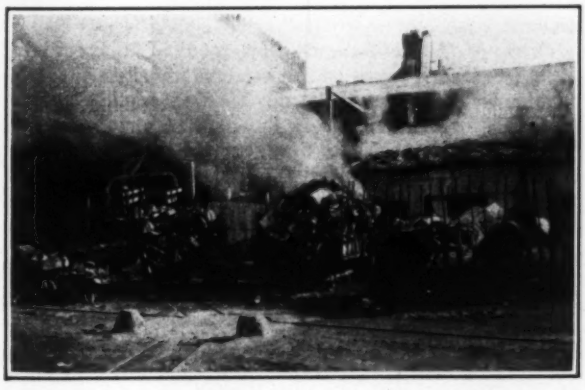
UNLOADING A TRUCK ON THE DELIVERY PLATFORM
The main belt conveyor moves along the front of this storage pile and is fed by raking or shoveling down material from the pile.

els onto the main conveyor belt, 48 in. wide and 133 ft. long. This belt, practically level, runs just in front of and below the storage pile to which the truck delivers.

Along this belt are stationed 7 men, 5 pickers on the floor beside the belt and 2 men on the pile or the platform above, whose function is to shovel or otherwise get the material onto the conveyor at the desired rate. Of the 5 pickers, 2 are detailed to take off bottles that have commercial value and put them in galvanized iron wash-tubs in which they are moved by an escalator to a sorting floor. After sorting, tubs of bottles are stacked in the yard awaiting the junkmen. Only about 40 per cent of the bottles that come intact in the refuse are salable.

The other three pickers take off the belt what is known at the plant as "riffraff." It includes all metal, except tin cans, that has value primarily for remelting. Items in this class include oil stoves, wire, stove pipe, galvanized iron, wire fencing, screens, etc. These are tossed over to a belt conveyor paralleling but running in a direction opposite to the main belt and are delivered to a corner of the yard where the material is loaded by hand onto metal cars for "burning." Granite-iron utensils are separated at this stage of the sorting to be later hauled to the dump—no economical means of salvaging granite-iron ware has been found.

The metal cars used for burning off combustibles before the "riffraff" is baled under the drop hammer are 6x10 ft. in plan and have racks or side walls 6 ft. high made up of 1-in. rods set vertically in the sides of the



CARS OF "RIFFRAFF" BEING BURNED TO BLACK METAL
Burning is done in the open on spur tracks reached from the turntable. Track in foreground leads to baling hammer.

car frame about 14 in. apart. Five of these cars are used; the fires are started with a little combustible rubbish and usually burn fiercely for about an hour. In this fire the paint, oil, paper, wood, etc., is burned up and the residue is rated as "black iron."

In these cars cooling after the fire is usually hastened by water from a hose and the metal is then dumped in a pile beside the baling hammer. Here two men feed the material by hand into a chamber under the hammer which weighs about 600 lb. and has a 7-ft. drop. The hammer can be set to trip automatically at a rate of about 25 blows per minute or it will drop only on the release of a hand trip when a slower rate is desired. The bales from this hammer are 20x20x24 in. in size and weigh about 350 lb., having about 16 per cent the density of pig iron. They are stacked nearby with the aid of an air-operated hoist to await delivery to steel mills where the metal is remelted.

At the delivery end of the main conveyor belt the tin cans are held to the belt by a magnetic pulley and are thus carried around to the under side of the belt while

PICKERS AT WORK ON MAIN CONVEYOR BELT
By loading the belt at the far end there is more opportunity for sorting. Storage pile in background. "Riffraff" belt at left.

other material drops free over the pulley. After finding that a considerable percentage of cans escaped this magnetic pulley due to heaping up on the belt or other causes, a second short belt was added just below the delivery, as the sketch shows, and with this second pulley as an auxiliary practically all the tin cans are taken out as the refuse goes by.

The cans are lifted by a bucket conveyor to a rotary incinerator. This is a 4-ft. cylinder, 15 ft. long, through which a gas flame plays continually and which is set at an angle such that the cans roll through without being heated enough to melt solder. The function of the incinerator is to burn off paper and to consume any combustible material that would interfere with the detinning process.

Cans are delivered to the detinning plant by a 36-in. belt conveyor along which are stationed two men, one to pick off any scrap metal that has escaped the pickers on the main belt below and the other to take off combustible material that has come through the incinerator unburned or other material harmful to detinning work.

In the detinning plant the cans are delivered to a perforated open-top cylinder in which they are chemically treated to dissolve the tin. The recovery is about 20 lb. of tin per ton of cans. The process, however, is interfered with and efficiency of operation is lowered by paper labels on the cans. These are extremely difficult to remove entirely and experiment on this problem is still under way.

On leaving the detinning plant the cans, as black metal, are dropped into a hydraulic press which reduces them to 8x18x18-in. bales. These bales weigh about 70 lb. and have about 11 per cent the density of pig iron. At this density they are sold to copper mills to be used as precipitate, or by further compressing to 50 per cent density the bales are sold to the steel mills for remelting. In addition to the average of 600 tons of tin cans per month delivered by the city of Los Angeles and detinned at this plant it has been necessary, in order to keep the plant busy, to purchase about 400 tons of cans and scrap tinned metal from nearby cities.

Returning now to the main conveyor belt, that part of the material that passes over its delivery end but does not go through the rotary incinerator includes a large percentage of dirt. This is sifted out in a tumbler consisting of a 4x12-ft. rectangular container, rotated to throw the material against the perforated sides, allowing the dirt and small waste to escape through openings, 1½ in. in diameter, into the dirt bin below.

The reject from this screen goes to a belt for a final picking. Here three pickers take off all metal and salable glass, allowing the unsalable glass (only clear broken glass has value), crockery, dirt, ashes, etc., to go on to the dirt bin. From the dirt bin 9 or 10 loads averaging 8 cu.yd. are daily taken to a dump on land where a fill is being made.

Pure clear glass, both fragments and small whole bottles that have no commercial value as such, drop by gravity from the sorting belt into a bin over the "glass washer." This consists of an inclined metal cylinder that rotates slowly as the glass is fed in at the upper end and passes under a jet of water. Delivery from this cylinder is to a conveyor belt which affords opportunity for a final inspection. The glass is inspected for color, and bottle tops or other foreign matter adhering to the bottles are here removed more effectively than could be done before the washing. As much breakage as can readily be secured is desired in the glass because a considerable part is shipped to China and the freight rate is lower on shipments whose density is such that the bulk does not exceed 40 cu.ft. per ton. From the glass bin a vertical chute controlled by a gate delivers the broken glass into sacks. Two men operate this gate, filling and piling the sacks which weigh 225 to 250 lb. each.

In addition to the refuse delivered by the city, and by way of improving the load factor on the plant, the By-Products Co. purchases each month about 200 tons of scrap sheet metal and other metal scrap which is baled under a 1,200-lb. drop hammer and sold to the steel mills. About 25 tons of discarded dry batteries are delivered to the plant each month and thus far all endeavor to find some means of salvaging this material has failed.

Despite the fact that the payroll of the By-Products Co. includes 40 men at the plant and one on the dump, only 35 per cent of the operating cost of the plant is for labor and employees generally (excluding office expenses and manager's salary).

The Los Angeles By-Products Co., organized two years ago, was originally a department of the Los Angeles Foundry Co., whose president, Lee Chamberlain, has directed its affairs for the past fifteen years and has succeeded in working out, usually without the aid of precedent, the frequently arising problems in economical handling of refuse. Operation is under the direction of C. M. Gregg, vice-president and manager.

Building Raised and Leveled After Irregular Settlement

Sanitarium Settles in Shifting Ground—Columns and Walls Cut from Footings—Screw Jacks Raise Superstructure

A SERIOUS case of settlement of a large building, necessitating extensive work to restore and maintain it, is that of the Madison County Sanitarium at Edwardsville, Ill., which was completed in May, 1926, at a cost of about $300,000. The three-story main building, about 143x145 ft., is L-shaped, with two wings for solariums or sun parlors at the south, and one at the north end. It is designed as a wall-bearing structure, except for eleven interior columns, which are of reinforced-concrete on isolated footings. The floor construction consists of concrete joists and slab resting on the walls and continuing over girders supported by the interior columns.

A few days after the occupation of the building, noises were heard and cracks developed in walls and floors, indicating distortion of the structure. The south wing or solarium separated from the main building by about 2 in. There was also an elongation of the foundations of the latter and the north solarium due to numerous cracks, so that the north end of the foundation wall was found to be about 4 in. north of its original position. Settlement at different points ranged from 3 in. to a maximum of 12½ in. Pipe lines and sewers appear not to have been affected seriously, but they have not been uncovered as yet, and it is possible that some joints have been pulled open.

The structural effects of the settlement are evidenced by cracks that have developed in the concrete foundation walls and in the brick exterior walls to some extent, together with some cracking of the floor slabs and partitions. No cracks have been discovered in the interior girders. Where the maximum settlement of the foundations occurs, the basement floor, resting directly on the ground and carrying no load other than its own weight, followed down with the foundation, showing that the ground under this plain concrete floor subsided as much as the ground under the loaded foundations. This fact, together with the fact that the soil pressure under the foundations was, in general, less than 4,000 lb. per sq.ft. on apparently firm, dry clay, indicates that the foundations were of sufficient size for ordinary conditions.

Cause of the Settlement—Movement of the ground is considered as a cause of the settlement, since the footing loads are well within the bearing capacity of the soil. Fissures or cracks in the ground have opened to widths of 1 in. to 20 in. and some of them are several hundred feet long. Their depths are unknown. As these fissures occur also at points distant from any buildings, it is evident that they are not due to loading. Although the building is located over the workings of a coal mine, the coal company is reported as claiming that a solid block of coal, with one slight exception, was left under the sanitarium. However, to the north of the building is an abandoned coal mine, and it is suggested that some soft stratum at a considerable depth has been gradually slipping away, probably entering the old workings. Inspection of this mine is impracticable on account of gas and débris.

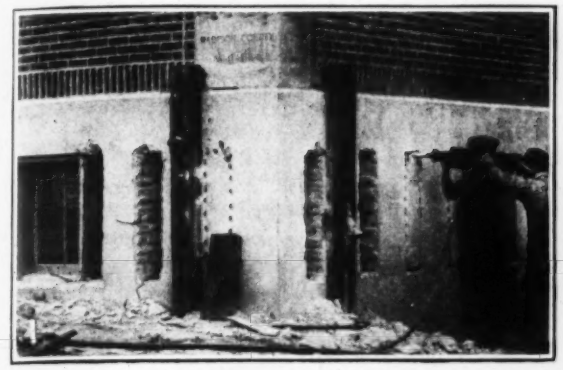
Raising the Building—After an investigation by engineers, steps were taken to control the movement of the building and to hold it in normal position. As the first step, a system of tierods was installed, crossing the building in both directions, in order to prevent further horizontal movements of the foundation. To raise the settled portions of the structure and restore them to level, it was necessary to use building jacks, consisting of drums, or screw jacks set in timbers. For this purpose, vertical slots about 3 ft. apart were cut in the 18-in. concrete basement wall, and this wall was cut loose horizontally at about the level of the top of the basement windows, as shown in Figs. 1 and 2, the first floor being at a height of several feet above the ground level. The upper part of the concrete basement wall then formed a beam which carried the superstructure and against which the lifting jacks took a bearing. Pneumatic drills and jack-hammers, served by a portable compressor plant, were used in cutting the walls and columns.

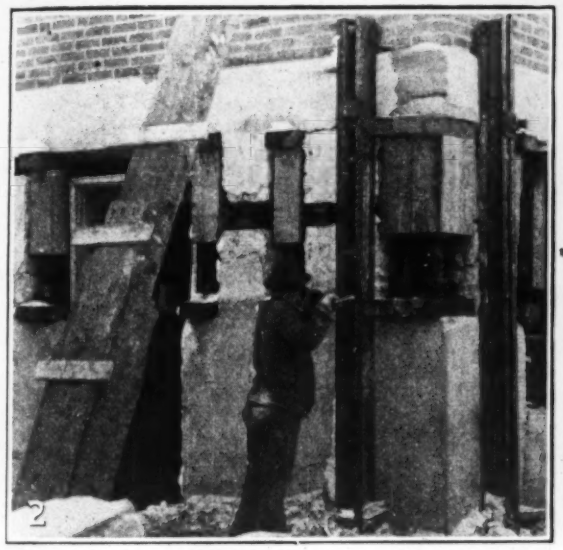
Jacks were set in these vertical slots in the outer walls, also in similar slots in the basement partition walls and in cribbing built around the eleven interior basement columns. These columns were cut apart some distance below the floor and blocking was bolted against the upper part of the columns, the jacks being fitted against this blocking, as shown in Fig. 3, so that the lifting was done on the columns and not on the floor-beams or girders.

In all, there were 488 jacks, each of 10 tons capacity. With all the jacks in position and with a knowledge of the settlement at various points, as determined by a continual system of leveling, the building was raised to normal position, leaving the lower part of the basement walls and columns in their shifted positions. This work was begun in September and completed in November, 1926, and the building will remain supported on the jacks until next fall. Meanwhile the series of levels and lines is continued periodically, and the jacks are adjusted as required. Only slight settlements have occurred since the jacks were placed, the maximum at any one point being about 1 in.

When the serious settlement began, T. L. Condron, of Condron & Post, consulting engineers, Chicago, was called in, and the method of holding the building and checking the movements was suggested by him. The work was carried out by the E. F. David House Moving Co. and A. H. Stiel, St. Louis, Mo., the former having a crew of 22 men. About two months were required for making the preparations, the actual raising being then done in four days.

During the work building has been occupied continually, as the engineers found no structural weakness or serious distortion.





HOSPITAL BUILDING OVER COAL MINE SUPPORTED ON JACKS

Fig. 1—Cutting slots in wall for jacks.
Fig. 2—Leveling building with screw jacks. This corner has been raised about a foot.

Fig. 3—Jacking interior basement columns. Screw jacks bear upon blocking bolted against the four faces of the columns.

Waterproofing the Upstream Face of Mountain Dell Dam

Membrane Made of Felt and Fluxed Asphalt Put On After Repairing Poor Concrete Damaged by Frost Action

THE Mountain Dell dam is a multiple-arch structure built in 1916 and 1917, about 13 miles from Salt Lake City to provide storage for the city water supply. The dam is located at El. 5,500 where winter temperatures have been known to go as low as 35 to 40 deg. below zero. As originally built the dam was carried up to a height of 100 ft. and provision was made in the original design for carrying it 40 ft. higher. The arches have a maximum thickness of 4.5 ft. at the base and 1.1 ft. at the 100-ft. level. The buttresses are 35 ft. apart, center to center, giving an arc of 120 deg. in the arches. The slope is 10 on 12. A description of the construction work was published in *Engineering News-Record*, March 7, 1918, p. 455.

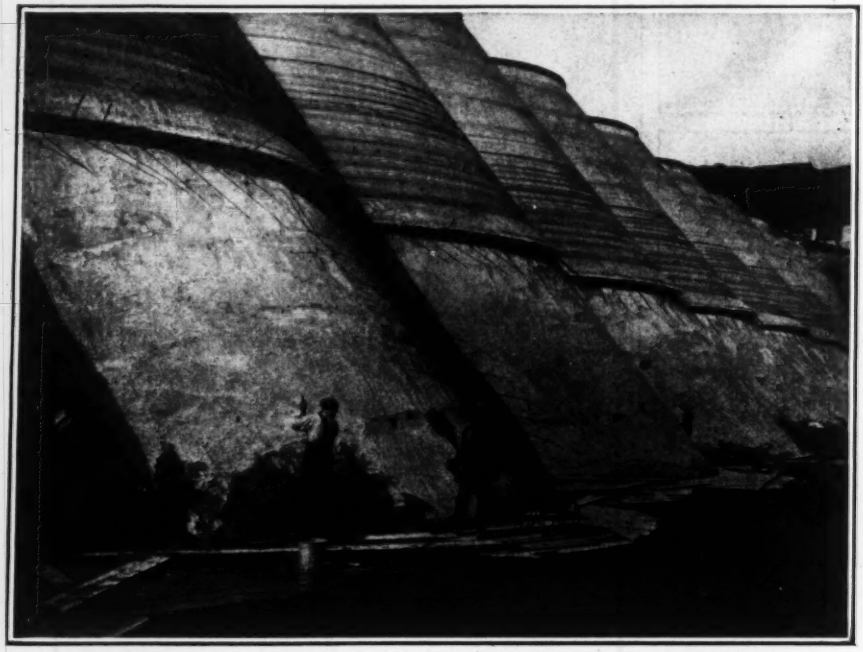


FIG. 1—PREPARING THE ARCHES FOR THE WATERPROOF MEMBRANE
The work was done from floating platforms which were lowered as desired by emptying the reservoirs. (Note 12-in. thickening at bottom of addition.)

Generally speaking the concrete was not first-class according to reports, due either to an excess of mixing water or to the fines in the sand or more probably a combination of both. The result was more or less perviousness and a resulting progressive disintegration due to the action of water and frost. Seepage through the arches was reported as early as 1919. This continued in somewhat increasing quantity and in 1924, when it was decided to increase the height by the 40 ft. originally planned, the extent of the leakage was such that it would have been necessary to repair the old arches even if the greater pressure of an increased head had not been planned.

By 1925 the percolation had increased to such an extent that there were numerous small drips through the construction joints, and practically the entire downstream face of the dam was damp. There was, however, no measurable amount of water coming through.

When preparations for raising the dam were begun surface disintegration covering approximately 3 per cent of the upstream face of the dam, varying in thickness from ½ in. to a maximum of about 2 in. was first repaired with gunite. Also practically all construction joints were cleaned out and repaired on both faces of the dam. The disintegrated concrete in the joints extended to a considerable depth in many places, and in a few places nearly entirely through the dam. In making these repairs it was noted that disintegration had occurred at all levels. In this connection it was pointed out that the reservoir had usually been filled in the fall, and drawn down during the winter to augment the low stream flow during cold weather. With the exception of the surface and construction joint disintegration mentioned, the concrete is reported to have been "in fair condition."

After the disintegrated concrete was cut out and the guniting finished, the raising of the dam was completed. In the runoff season of 1926, when water was next stored behind the dam, the head on the arches repaired by guniting was raised to 96 ft. Even under this increased head the dampness on the downstream face was less than before the gunite repairs. The leakage through most of the joints had lessened considerably and through three or four cracks that were covered with extensive patches the leakage was stopped entirely.

Only a small percentage of the total area of the upstream surface had been covered, however, and due to the increased head percolation continued at a more rapid rate through concrete that had not been covered. It was then decided that the guniting was not the complete remedy needed and some other method must be adopted.

At the time that work on the 40-ft. additional height was begun, it was planned to cover the refinished and waterproofed portion of the arches below with a protective layer of concrete 12 in. thick. With this in view the bottoms of the arches on the addition were made 12 in. thicker than the old arches, as the pictures show, so as to afford a suitable bonding joint for the greater thickness in the arches below. This 12-in. thickening was made at this level only and does not extend to the top of the dam.

After considering various means of waterproofing the old arches, however, it was decided to use only an asphaltic membrane without the protective covering of concrete. As the asphaltic membrane would be subject to heads ranging up to 140 ft., it was decided to build it up of several layers of preformed membrane suited to heavy duty. Specifications were prepared stipulating

that the membrane should consist of all-wool felt and fluxed asphalt weighing not less than 635 lb. per square.

While notice to contractors was being published the city proceeded with the work of preparing the arches for receiving the membrane. This work consisted in first removing all dirt and disintegrated concrete from the surface. All projections were chipped off and depressions were filled with cement mortar; also the notches between the corbel heads and the arch rings were filled with concrete so that the entire face of the dam was made as smooth as possible for the reception of the waterproofing material.

The first operation in putting on the membrane consisted of heating the surface of the concrete by means of kerosene torches. When thoroughly heated and dried out a concrete primer coat, weighing approximately 10 lb. per square, was promptly put on. Next, a flood coat of approximately 50 lb. of fluxed asphalt per square was applied. This was followed by successive layers of preformed membrane and fluxed asphalt mopping courses, the moppings weighing approximately 40 lb. per square.

Three layers of preformed membrane were used, each made up of sheets 3x5 ft. in size and about ¼ in. thick weighing 150 lb. per square. These sheets consisted of an all-wool felt envelope filled with fluxed asphalt. Each sheet was heated before placing and was thoroughly hammered into place with wooden mallets to insure adhesion at all points. Each course was mopped on and a mopping was put over the last course.

After this 3-ply covering a cap sheet of all-wool felt was put on working from the bottom to the top of the dam and finished off with a mopping course. As a final protection against abrasions a final flood coat was applied working from the top to the bottom.

FIG. 2—PUTTING ON THE ASPHALTIC MEMBRANE
The surface was first treated with concrete primer, then with fluxed asphalt and each layer was put on with moppings. The fourth layer and final covering made the total thickness more than 1 in.

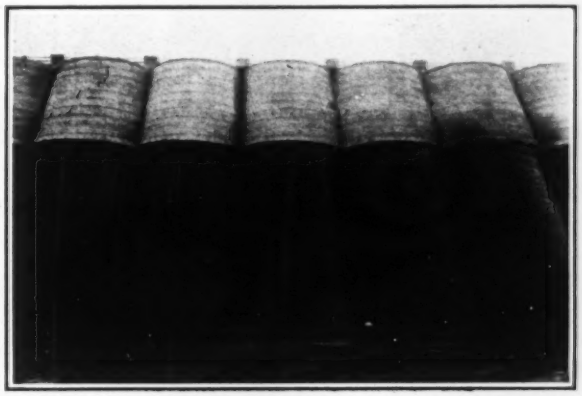


FIG. 3—MOUNTAIN DELL DAM ON COMPLETION OF NEW SURFACING
The white portion above is the concrete recently added in raising the structure. Asphaltic membrane on old arches appears black.

The total thickness of the waterproofing membrane is in excess of 1 in. and the weight per square is about 670 lb. The membrane was keyed to the top, sides and bottom by beveling off the edges and then placing alternate layers of asphalt and asphalt-saturated cotton fabric strips. Four strips of the fabric were used, the first being 9 in. wide and the last 28 in. wide.

The contractor commenced work Sept. 28 last; the work was practically completed Nov. 9, and the gates were closed Nov. 10. At the time this report was written there was approximately 20 ft. of water in the reservoir and the membrane had shown no signs of leakage. The thought is that if a few leaks should develop it may be possible to stop them by patching or giving the membrane additional moppings.

The contractor on the work was the Galigher Machinery Co., Salt Lake. The work was done under the general direction of Harry C. Jessen, city engineer, to whom *Engineering News-Record* is indebted for the foregoing data.

Power Possibilities of Clearwater River

Recently the Geological Survey completed the mapping of the main Clearwater River and its principal tributaries—North, South, and Middle Forks, Selway, and Lochsa Rivers—for a total of 429 miles. Warren Oakey, hydraulic engineer who accompanied the topographic surveying party, reports that only five power sites having an installed capacity of 12,400 hp. have been developed and that there still exist power sites for the development of 184,000 hp. at ordinary low water flow or nearly 380,000 hp. for 50 per cent of the time. No storage is being used and no feasible storage reservoir sites were found. The results of the survey and investigation are contained in a report entitled "Storage and Power Possibilities, Clearwater River Basin, Idaho." The report is available only in manuscript form at the Geological Survey offices at Boise, Idaho, Salt Lake City, Utah, and Washington. The river survey map, seven plan and seven profile sheets, may be obtained from the Geological Survey, Washington, for $1.40.

Flood Danger in the Colorado Delta—

Channel Construction the Only Safeguard

By Paul M. Entenman
Civil Engineer, Banning, Calif.

A RECENT reconnaisance and airplane investigation of the channels of the lower Colorado reveal a condition on the delta that portends disaster to Imperial Valley unless effective measures are undertaken to strengthen the levees and, later, to provide the river with an open channel to the Gulf. There is now no clear channel to the Gulf, and the river finds its way over the delta cone at the end of the Pescadero Diversion through innumerable small shallow channels that filter through the dense jungle growth of mesquite, willow and cottonwoods that obstruct free flow to the Gulf. One of the photographs shows the lower end of the river as seen from an airplane.

The Erosion Danger—In 1905-06, when the Colorado flowed through New River channel into Salton Sea in the Imperial Valley, it eroded a deep gorge 43 miles long averaging 1,000 ft. wide and from 40 to 80 ft. deep. The erosion took place with astonishing rapidity, not as a gradual, uniform deepening of a long channel, but as a recession, such as occurs at the face of a falls. The upstream movement of this face was at times as great as 8 miles a month.

AN IMPORTANT article on the Colorado River situation, received too late for inclusion in the group which we published March 17, presents a sharply alarmist view of conditions in the river's delta plain. The author has been closely connected with river and canal work in the Imperial Valley region for many years and speaks with close, personal knowledge. It is his belief that immediate danger of a disastrous outbreak of the river threatens. Dealing with the crucial question of how long the Pescadero Diversion will provide a safe course for the stream, he finds that this channel is already unstable, and that a flood of large volume in 1927, following the small floods of recent years, is very likely to breach the whole protective system of the delta. Like J. C. Allison, he proposes channel construction on a grand scale as the only permanent solution.—EDITOR.

(For locations and topography in the Colorado delta, refer to the map, p. 441 in the March 17 articles.)

The significance of the capacity of the river to erode a deep channel by recession lies in the fact that a relatively small flow on a steep grade can develop a large deep channel which will quickly cut back to the main channel of the river. In 1906, when the river was returned to its channel to the Gulf, and flow into New River ceased, the recession was halted at a point about 6 miles southeast of Calexico. From that point New River continues south as a shallow channel to the Volcano Lake basin which it formerly served as an overflow channel.

If a breach in the levees permitted 10 per cent of the normal flood discharge of the river to enter New River, channel recession would quickly reduce the shallow channel to a deep gorge, and the development would be very rapid as it neared the Volcano Lake region where the soils are an especially friable alluvium. Assuming that the quantity entering the New River from a breach was only 10,000 sec.-ft., the increased velocity on the steeper slopes to the north would sufficiently increase the silt carrying capacity of that flow to transport the eroded material to the Salton Sea. The percentage of silt transported by the river varies between 0.5 per cent and 4.0 per cent which variation corresponds approximately to the fluctuations in velocity. If the higher velocity along the northern route increased the percentage of the silt transported by only 1 per cent, a total of 320,000 cu.yd. per day would be moved, a quantity in excess of the amount of material which would be eroded by a process of channel recession.

Unless such a recession was checked before the deepened channel made a connection with the main channel of the river, the barranca would cut through some of the main canals, and, traveling upstream, would lower the surface of the river below the sill of the intake. When the existing gorge was formed in 1906, two large mains, the West Side Main and the Central Main, were destroyed by the recession, and 30,000 acres of cultivated land were left uninhabitable for about a year and a half. A greatly increased area of cultivated land on the west side of the valley would again be the first to suffer if the river entered New River, but if the movement got out of hand, the recession might travel 300 miles up the Colorado River destroying the Laguna dam and all the irrigation projects on the lower river.

Channel Changes—The Colorado held its course to the Gulf along the east side of the delta without marked changes in the position of the channel for at least 55 years between 1850, the date of the settlement of Yuma, and 1905, when the river flowed into the valley. (The early explorations, except that of Hardy, seem to have followed this same course, and it is probable that the course was virtually unchanged for 300 years; but there are no reliable records before 1850 which show the actual course to the Gulf.) The Volcano Lake basin served as an outlet only 9 years, 1909 to 1918, before a change in direction of the river channel occurred; and the Pescadero basin, into which the river has flowed since 1922, has filled so rapidly in the four and a half years since the diversion was developed that a tendency to move off the débris cone at the end of the diversion channel has already become manifest.

Bee River Diversion—The Colorado left its old course to the Gulf along the east side of the delta during the

FIG. 1—HOW THE COLORADO RIVER DISAPPEARS INTO ITS DELTA

Airplane view looking southwest from the south end of the Pescadero Diversion. The view shows the absence of any channels of large capacity to carry the river to the Hardy and the Gulf. The Gulf of California shows in the distance.

summer flood of 1909, and, following the more favorable slopes of the Bee River Channel, emptied into Volcano Lake basin. The depression held Volcano Lake, a body of water 10 miles long, 6 miles wide and about 13 ft. deep, fed by overflow streams from the Colorado. The slope along the Bee River channel was 2.2 ft. per mile. Within 9 years, the lake depression was so filled with silt that the river left its channel in 1918 and moved north against the Volcano Lake levee. During the flood of 1921, the elevations in the lake area were 13.7 ft. higher than those of 1908, and the slope of the Bee River channel had been reduced to an average of 1.1 ft. per mile.

Pescadero Diversion Not Stable—In 1922, at the time of making the Pescadero diversion, it was anticipated that the channel would be eroded to a connection with the existing deep arroyo of the Pescadero, and that the river would carry its silt into that channel and distribute it over a wide area as it overflowed the banks. No such result has been effected. The silt was deposited on a new delta cone at the end of the diversion, and the water of the flood was spread in a thin sheet over the cone, eventually entering a large number of small shallow channels which gather into the Pescadero River. Consequently, there was a rapid upbuilding of the cone followed by a flattening of the slopes in the diversion instead of a recession to the elevation of the bottom of the old Pescadero arroyo. In 1922, the slope of the water surface for 6 miles below the dam was between 2.5 and 3 ft. per mile. In 1926, the grade had flattened in this distance to approximately 1.0 ft. per mile.

FIG. 2—EROSIVE ACTION OF RIVER AS IT IMPINGES ON A LEVEE

Inundation of low areas behind this levee was prevented by constructing a "shoo-fly" levee around the eroded section.

It is noteworthy that former channels became unstable when their grades flattened to slopes approaching 1.25 ft. per mile, and the difficulty of holding an align-

ment to the south to the Pescadero basin became apparent last year, when the river, discharging less than 70,000 sec.-ft., broke through the levee at a point 6

FIG. 4—BREACH IN PESCADERO LEVEE DURING FLOOD
The heavy foliage showing in this view is typical of the growth on the delta cone through which the river filters to the Hardy. Such vegetation retards velocity and causes heavy silt deposition, thus rapidly elevating the cone and flattening the river slopes with resultant widening of meanders.

miles below the dam on June 12, 1926. The water entering the breach spread as far north as the edge of the old Bee River channel. A breach occurring with a greater flood flow, might discharge such a large percentage of the stream into the Bee River that the lower end of the Pescadero Diversion would quickly silt full and no flow would enter the Pescadero basin. In that event, that portion of the Pescadero Diversion that remained intact would become merely a bend in the Bee River, and there would be a return to the conditions of 1921 with the Volcano Lake levee serving as the only barrier between the river and Imperial Valley. Moreover, the danger to the valley would be markedly greater than prevailed in 1921 for the reason that the outlets to the Hardy River from the Volcano Lake area have been out of use since 1922 and are partly silted full, and also because the Volcano Lake levee has not been maintained as a primary line of defense.

New Outlets—The up-building of the cone at the end of the Pescadero Diversion leaves no low areas into which the river may be diverted to effect a lowering of

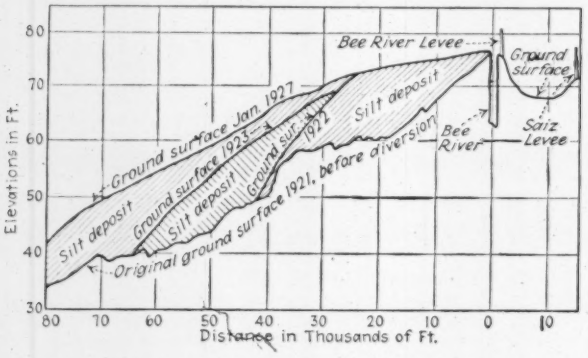


FIG. 3—PROFILE OF GROUND ELEVATIONS ALONG THE PESCADERO
Showing the heavy silt deposits.

the flood plane against the levees. Two solutions remain: the extension of the Pescadero levee southwest to ground high enough to cut off any northward flow to Volcano Lake, or the return of the river to a channel along the east side of the delta.

The extension of the Pescadero levee will serve merely as a temporary expedient. The grade of the Diversion and of the Bee River will continue to flatten as the elevation of the delta cone rises, and on the flattened slopes meanders will develop that will endanger the levees. Such a meander breached the Bee River levee in 1925 when the flood was small. Long before any dams can be effective, the silt deposits will have elevated the cone to such heights and so flattened the slopes that a meander of the river would break through the levee and follow a more favorable grade.

Eastern Channel Solution—The return of the river to a course to the Gulf along the east side of the delta offers the only satisfactory permanent solution. The river should be turned into a straight channel to tide-water. The distance along its present route is 15 miles longer than the proposed new route to the Gulf. From the Arizona boundary to tide-water, the fall in 30 miles is 70 ft. at maximum high tide, with an extreme tidal range of 32 ft.

The diversion of the river to a channel to the east

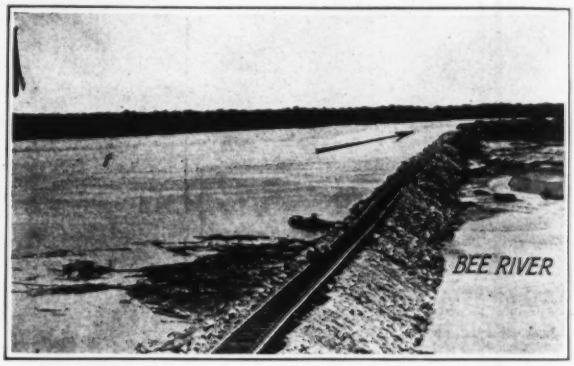


FIG. 5—BEE RIVER DAM AND THE COLORADO ENTERING THE PESCADERO DIVERSION

side should be no casual effort. No attempt should be made to use the old channel of the river, which is filled with silt for much of its length and obliterated by a heavy jungle growth; nor should the Santa Clara Slough be utilized. It will be necessary to excavate a channel to an actual physical connection with the tidal estuary that leads to the Gulf.

As the silt from this channel would be deposited in the waters of the Gulf or on tidal flats that occur at the head of the Gulf, the development of a delta cone at the outlet would be exceedingly slow. There would be no concentration of the silt deposits over a small area as there is at the end of the Pescadero channel where the river drops its silt as its velocity is retarded by the thick growth of willows and mesquite as it spreads over the cone. With such an extreme tidal range as 32 ft., the tidal currents at the head of the Gulf are swift and turbulent, the incoming tide being usually accompanied by a tidal bore with a wave 4 ft. high. Silt dropped into those currents will be widely distributed, as was quite evidently the case for the many years the river occupied this position prior to 1909.

Immediate Danger—If no work is done to close the breaches in the Pescadero levee, or to strengthen and repair that levee where convex curves of the river threaten impingement, the Pescadero Diversion will

surely be lost. A policy which would result in the loss of the Pescadero Diversion and the return of the river to a channel to Volcano Lake would be an engineering and economic blunder of the first magnitude.

Reports from the Weather Bureau at Denver are to the effect that the snowfall in the upper drainage basin of the Colorado River is 48 per cent heavier than normal. Since 1922, the river has discharged less than 100,000 sec.-ft. in the summer floods as against a discharge nearly twice as large at maximum peaks of previous years; so that there has been no real test of the capacity of the present channels. If the June flood this year is abnormally high and the levees are not amply strengthened to guard against incursion from the river, breaches may occur which will destroy the usefulness of the Pescadero Diversion and throw the stream against the Volcano Lake levee, the only barrier between it and Imperial Valley. The Volcano Lake levee should be immediately restored and strengthened to the capacity of a first line of defense, and the Bee River and the Pescadero levees should be repaired and strengthened at points of possible attack. Investigations should be begun at once toward selecting an alignment for the channel along the east side of the delta, and the work of constructing the channel for the diversion to this route should be begun as soon as the flood subsides. The cost of the diversion will be small compared to the losses that would be suffered by Imperial Valley should the river break through the levees and flow into the valley.

Brick in Engineering and Architecture

More Research Needed—Tests on Strength of Walls and Piers—Old Building Codes Need Revision—Brick and Concrete

THAT a widening field for brick masonry will be developed as the result of extended investigations completed recently by the U. S. Bureau of Standards was the theme of a paper read at the recent annual meeting of the Common Brick Manufacturers' Association, at Chicago, by L. B. Lent, engineer, for the association. An abstract of his paper is presented in the following:

The engineer has at his commond all the necessary data regarding the strength of all sorts of structural materials except brick. Our data relating to the strength and other properties of brickwork are largely what have come from years of experience. As this information is not the result of laboratory determinations it is assumed to be of questionable value, so that we must assign to brickwork lower strength values than it might otherwise be entitled to.

Brick is often seriously penalized in building codes. Many of these are copies of older codes based upon early practice and assuming that poor grades of brick, mortar and workmanship might be used. Hence their provisions are unfair to present-day brick masonry of superior quality. Why should the allowable wall thickness be the same for concrete block having a crushing strength of 700 lb. per sq.in. of gross area, as for brick having a crushing strength of 7,000 lb. Such a provision is found in many codes. Most codes require 12-in. brick curtain walls for steel frame structures; these walls carry practically no load, and we know that an 8-in. wall gives ample strength and fire resistance. Yet they allow an 8- or 6-in. concrete wall under the same conditions.

The attitude often shown by architects, engineers and building officials is to place a higher value upon data derived from laboratory experiment than upon evidence of performance. And in many respects they are right. General statements as to the value of brick, while true enough, do not register in the technical mind as does the precise statement that an 8-in. wall of brick of only 3,000-lb. strength will safely carry a load of 12 tons per running foot.

The series of tests on brick walls just completed by the U. S. Bureau of Standards is the first comprehensive investigation and by far the most important and authoritative investigation of its kind. Of numerous investigations made since 1882, only two have been upon walls, all the others being upon brick piers. Most of the older building codes have permitted a working compressive stress of 250 lb. per sq.in. on masonry constructed even of medium grade brick. But one firm of engineers has used as high as 500 lb. on piers of carefully selected brick and portland cement mortar, built under careful supervision to insure good workmanship.

Engineers profit by using these higher stresses because in many cases they can build a brick wall of the necessary thickness cheaper than they can build a reinforced-concrete wall faced with brick or some other necessary facing material. And they can build it in less time. Some engineers and contractors are going back to brick foundation walls, because such walls can carry the load, can be made waterproof, and can be built in about the same time as concrete walls, while there is no waiting for concrete to set and cure. To those who look upon the thicker walls as furnishing a larger market for brick, the answer is that thicker walls are not used, but are replaced by thinner allowable concrete walls, and there is then no market for brick.

As to the permanence and fire and weather resistiveness of brick masonry, the brick industry has a vast amount of data obtained over a long period of time. We lack only that evidence regarding strength, which can be produced in a relatively short time in the testing laboratory. This evidence is already in hand and when we can present it in the form of authoritative data developed by the U. S. Bureau of Standards we should be able to convince architects, engineers, building officials and code officials that brick masonry is entitled to a place which is now denied to it in many instances.

Incised and Treated Fir Beams Show High Strength

TESTS of the strength of beams of creosoted douglas fir, incised to increase the oil penetration, show results comparing favorably with similar beams not incised, according to tests made by R. H. Rawson, consulting timber engineer, Portland, Ore., and presented at the recent annual meeting of the American Wood Preservers' Association. These tests supplement those reviewed in *Engineering News-Record* of Dec. 30, 1926, p. 1084, and upon them the following conclusions are based:

(1) Incising or slitting the faces of timbers to permit a more uniform penetration of creosote or preservative, affects the strength of douglas fir beams in bending only slightly; a loss in fiber stress at elastic limit, modulus of rupture and horizontal shear being a trifle over 2 per cent. (2) The combined effect of incising and treating may reduce the fiber stress at elastic limit slightly more than 10 per cent, while in modulus of rupture and horizontal shear the reduction is less than 7 per cent. (3) Incising caused douglas fir to absorb 43.46 per cent more creosote than timbers not incised, when treated under identical conditions. (4) To illustrate that a reduction in modulus of rupture of less than 7 per cent does not materially influence the safe working stress in timber design, curves show that treated timbers have an average of 1,288 lb. per square inch greater strength than the untreated timbers for a period of slightly more than 45 years. (5) Seasoning douglas fir by boiling under a vacuum does not weaken the timber to any further extent than does such air seasoning as occurs in usual practice.

Features of Railway Engineering Practice and Economics

Extracts from Committee Reports at the Annual Convention of the American Railway Engineering Association Giving Reviews of New Developments and Investigations in Progress

FROM year to year committees of the American Railway Engineering Association record developments that have taken place in their special fields during the year, the results of tests or experience with materials or new methods.

The most significant of these committee reports given at the recent annual meeting in Chicago are abstracted below.

* * *

Comparison of Ruling Grades

Committee on Economics of Railway Location

AS A broad assumption, a grade of 0.4 per cent is good, 0.3 is better and 0.2 is better still, provided there is traffic to justify the cost of securing it. In the studies of J. B. Berry, formerly chief engineer of the Union Pacific Ry., it is stated that: "No advantage, except a reduction of time, would be gained by reducing grades below 0.4 per cent, as the starting resistance of trains on the level would limit the weight of the train." But improvements in car trucks and bearings and the generally higher standard of track maintenance have modified the applicability of this statement, for the performance of trains on grades of 0.3 per cent or less seems definitely to controvert it, even where boosters are not used. While there may be a limit below which it is not economical to reduce grades on account of starting resistance and because of the difficulties incident to proper drainage, the general opinion, based perhaps more on observation than on actual tests, seems to be that 0.2 per cent is that limit. The increasing use of the locomotive booster and the possible use of roller bearings for freight cars are developments that may exert profound changes in the studies for grade reduction. The use of stokers or of oil fuel have also modified the former limits for long grades by eliminating the element of human fatigue. The average speed of the trains over the road is one of the factors in any grade-reduction study.

* * *

Bearing Tests for Rolling Bridges

Committee on Iron and Steel Structures

THE portion of the truss or girder of a rolling bascule bridge that comes in contact with the support is a part of a cylinder; the bridge is counterweighted in such a manner that the center of gravity of the moving leaf and the counterweight falls at the center of the cylinder; and the bridge opens and closes by rolling back and forth on a horizontal track on the substructure. The design of a loaded cylinder rolling on a plane surface is a problem in stress analysis that has never been solved satisfactorily.

Curved sole plates on the rolling surface fail by progressive longitudinal extension under continuous rolling; cast segments deteriorate by a gradual disintegration of the surface due to local overstress.

Static tests indicate that the load per linear inch of segment producing set is affected by various factors, as follows: (1) This load increases as the length of the segment up to a length of approximately 6 in. and then remains constant; (2) it increases according to a straight-line law with the diameter between 120 and 720 in.; (3) for steel castings, this load depends upon the hardness, increasing as the Brinell number increases but remaining constant or decreasing above approximately 190; (4) for segments 120 to 720 in. in diameter the load that produces set is not affected by the size of the specimens if they are 6 in. in depth or more, but it is affected if the depth is too small.

The rolling tests show: (1) The minimum load producing a progressive elongation under continuous rolling increases rapidly with the thickness of the plate; (2) this load is considerably less for thin plates than the load that produces set as determined by static tests on deep blocks.

The design load for a rolling bascule bridge should be governed by the load producing set under static test or the load producing longitudinal extension under continuous rolling, whichever is the smaller. The former has been determined for steel castings of medium grade, the latter remains to be determined.

* * *

Economy of Treated Timber

Committee on Wooden Bridges and Trestles

IF PROPERLY handled in the creosoting plants, the strength of the timber is not materially reduced and it can be used with the same working stresses as untreated timber. The fire hazard is somewhat reduced, and if ballasted deck bridges are constructed of treated timber the hazard from inflammatory material dropped from trains is nearly eliminated. Creosote in timber is not injurious to metal fastenings. Sapwood, when treated, is preferable to heartwood. It is inherently as strong and takes the creosote more readily.

* * *

Boring Spike Holes in Ties

Committee on Ties

THE pre-boring of cross-ties is considered good practice by a considerable number of railroads, and in the last few years there has been a large increase in the number of boring and adzing machines in operation at wood preserving plants. Most roads bore a hole $\frac{1}{16}$ in. smaller than the cut spike in hardwood, and $\frac{1}{8}$ in. smaller in softwood. However, in the case of $\frac{5}{8}$-in. cut spikes in hardwood ties the practice is almost evenly divided. One road reports using the boring bits first in hardwood ties and after they begin to show some wear using them in softwood. All roads using screw spikes bore the hole the same size as core of spike, with the exception of one which bores $\frac{1}{32}$ in. less than core in pine ties. Most of the roads bore entirely through the tie.

Much less mutilation of the wood fiber results from driving a cut spike in a bored hole than when a cut spike is driven in the solid wood; the resistance to withdrawal of a cut spike driven in the bored hole is greater than when driven in solid wood. Opinion is general that more resistance to the lateral pressure of the rail flange is offered by bored holes, as the spikes have a solid backing instead of being surrounded by torn and broken wood fibers. While it is very desirable to ascertain which size of hole offers greatest resistance to withdrawal of the spike, it is even more important to ascertain which size of hole offers the greatest resistance to the horizontal pressure of the rail flange.

* * *

Battering of Rail Ends

Committee on Rails

JOINT battering cannot be entirely prevented, but may be ameliorated. The most promising sources of such amelioration are exhaustive studies of mill conditions, track construction and maintenance. Evidence indicates that rail battering is approximately proportional to the width of the joint gap. Effective anchorage applied at the time the rail is laid (in both directions on single track) is essential toward the preservation of the expansion spaces provided

in the original laying of the rail. The maintenance of adequate bolt tension, but not greatly exceeding that required to produce the maximum strength of the joint, is essential toward the maintenance of proper expansion spaces.

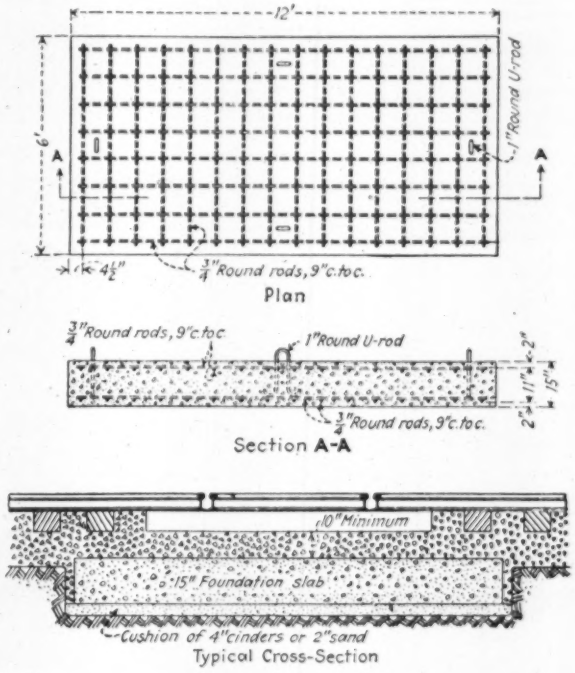
* * *

Concrete Foundation for Track Crossing

Committee on Track

A PROPOSED design for a reinforced-concrete foundation for railroad crossings is presented, as the drawing shows, but is recommended only for angles above 40 deg. Slabs 6x12 ft., slightly offset, may be used, but some roads prefer to make special slabs that more nearly fit the angle of crossing.

Wood pile foundations for crossings, when used in filled



CONCRETE SLABS FOR TRACK CROSSINGS

or marshy ground, are of two types: (1) A pile under each crossing frog supports a heavy timber frame carrying the track crossing; (2) piles driven close together are covered with 12 to 15 in. of ballast. One road reports that the rigidity of the timber frame produces hard riding. With concrete and pile foundations, the life of the crossing is prolonged and the maintenance cost is materially reduced. Information on structural steel foundations is meager, but the indication is that they are not as satisfactory as those of concrete or piles.

* * *

Car Retarders in Gravity Yards

Committee on Yards and Terminals

IN DESIGNING a retarder hump yard the question of grades should be carefully studied. Climatic conditions, character of the loads and equipment, prevailing winds and proper compensation for curvature should be taken into account. The yard tracks near the throat of the ladders have less resistance than the outside tracks on account of the route being more direct, with fewer curves and switches, while the grades on the inner tracks extend farther into the yard. For these reasons, they should be assigned to classifications having a light, slow-running class of cars. Compensation for curvature should be less for heavy loads than for empties; 0.025 per cent per degree of curvature is suggested for tracks on which heavily loaded cars or free running cars, such as loaded refrigerators, are handled exclusively; 0.04 per cent for empties and 0.03 per cent for the average run of traffic. Where mixed cars are handled, the empties are allowed to enter the lead at greater speed than the loaded cars. The speed of all cars is regulated when leaving the lead to take care of the variation in length of grade in body tracks through the yard.

The car retarder has been confined principally to hump classification yards, but it is adaptable for other gravity tracks, such as at ore docks and coal tipples. An example is the recent installation at the coal unloading plant of the Commonwealth Edison Co., Chicago. Conditions may also be found where retarders can be used to advantage in small yards, or for certain tracks in large yards where the switching is done mainly by shunting.

* * *

Profiles for Switching Humps

Committee on Yards and Terminals

SUITABLE grades and designs for any one yard are separate and distinct problems for that yard and are dependent upon the location, the traffic to be handled and the number of classifications. This statement is fundamental and it is impossible to set up a definite profile. However, if all the different elements which affect the operation of a hump yard are studied, the maximum and minimum effect of each can be determined and tables or graphs prepared, so that, having determined upon certain limiting values for the different variables, the length and rate of grades can be determined for each specific case. This method would be more useful than any typical profile which could be submitted. With the introduction of car retarders in recent years, the question of proper grades and arrangements of classification leads has been materially affected, and the question of low grades for retarder operation should be included in the problem.

Electrification Results in South Africa

Operating advantages resulting from the introduction of electric traction on the 175-mile stretch of main line from Glencoe to Pietermaritzburg in Natal, South Africa, are reviewed in the annual report of Sir W. W. Hoy, general manager of the South African Government Railways and Harbors. The change to electric traction was made in June, 1926, and a three-unit electric locomotive with one crew now takes a train load of 1,500 tons over the entire distance from Glencoe in 10¼ hours, running at 25 to 30 m.p.h. and maintaining a speed of 21 m.p.h. on the ruling grade of 1.54 per cent. With the most powerful steam locomotives the load was 1,000 tons at starting, but was reduced to 820 tons over the section having the ruling grade (at 8 m.p.h.), and then increased to 850 tons for the remainder of the trip, the total time being 16½ hours. These changes with the necessary switching movements, consumed much time. In the reverse direction, from Pietermaritzburg, the electric locomotive takes an 800-ton load in 10 hours, while a steam locomotive formerly took 385 tons in 14 hours. Passenger trains are hauled in 30 to 40 minutes less time for the 175-mile run. An important advantage is that the electric locomotives are available during about 90 per cent of a 24-hour day, while with the steam locomotives the available time was not more than 50 per cent. The electric engines have made 75,000 miles without requiring heavy repairs, while the steam engines rarely exceeded 25,000 to 35,000 miles before needing repairs. Again 78 of the electric locomotives are handling a heavier traffic than the former 130 steam locomotives. All the electric engines haul both passenger and freight trains, and operate on the 3,000-volt direct-current system.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Hydraulic Jump Formulas

Sir—In your issue of Jan. 20 p. 126, Frank S. Bailey raises a point as to the applicability of my formulas for the hydraulic jump published in *Engineering News-Record* of June 4, 1925, p. 928.

As plainly stated in the article, the notation and formulas apply to a unit width of channel.

Formula 11, however, is applicable to any type of channel if Y_c is interpreted as mean depth instead of total depth. In order to make the proof perfectly general let

s = elevation of water surface above any arbitrary datum.
e = elevation of energy head above the same datum.
Q = flow.
v = velocity.
h = velocity head.
a = water area in any cross-section.
t = top width of water surface at the elevation s.
d = mean depth, or area divided by top width of water surface.
c = subscript indicating values corresponding to critical flow.

The width of any irregular section is some function of the elevation of the water surface or at least is expressable by a series of functions each applicable between certain limits:

$$t = F_1(s) + F_2(s) + \qquad (1)$$

The elemental area at any elevation is $t\,ds$ and the total area is

$$a = \int_{s_0}^{s} t\,ds = \int_{s_0}^{s_1} F(s)\,ds + \int_{s_1}^{s_2} F_2(s)\,ds + \qquad (2)$$

The first derivative of the area therefore is

$$\frac{da}{ds} = t \qquad (3)$$

The energy head at any point is

$$e = s + h = s + \frac{v^2}{2g} = s + \frac{Q^2}{2ga^2} \qquad (4)$$

or

$$e = s + \frac{Q^2}{2g\int^2(s)} \qquad (4)$$

where $\int(s)$ is written for the sum of the several functions between their respective limits as in (2).

Placing the first derivative of (4) equal to zero

$$\frac{de}{ds} = 1 - \frac{Q^2}{g}\,\frac{\int'(s)}{\int^3(s)} = 0 \qquad (5)$$

Where $\int'(s)$ is the first derivative of $\int(s)$

then

$$\int^2(s) = \frac{Q^2}{g}\,\frac{\int'(s)}{\int(s)} \qquad (6)$$

is the condition for which (4) is a minimum but $\int(s) = a$

and $\int'(s) = t$ therefore

$$\int^2(s) = \frac{Q^2}{g}\,\frac{t}{a} \qquad (7)$$

The value of the minimum energy head is found by substituting (7) in (4), thus

$$e = s + \frac{a}{2t} = s + \frac{d}{2}$$

By definition, critical flow is that for which the energy head is a minimum, that is,

$$e_c - s_c = \tfrac{1}{2}\,d_c$$

but

$$e - s = h$$

hence

$$h_c = \tfrac{1}{2}\,d_c \qquad (8)$$

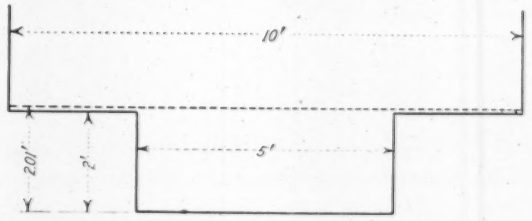
that is, at critical flow the velocity head is equal to one-half the mean depth.

The remainder of the formulas, however, are not applicable to flow in irregular shaped channels except in so far as unit widths may be indicative of flow in the entire channel.

The derivation of corresponding formulas for any shape of channel would constitute a fit subject for a separate paper and cannot be discussed at this time.

Portland, Ore., J. C. STEVENS,
Feb. 15, 1927. Stevens & Koon, Consulting Engineers.

Sir—I have looked over Mr. Stevens' equations and the deductions he makes appear to be correct. However, in a section such as illustrated below, where there is an abrupt change in the value of t, the formula for critical flow, i.e., velocity head equals one-half the mean depth, cannot be depended on by itself alone to determine the critical flow.



If it is assumed that the water surface in the above section is at the dotted line, the total depth is 2.01 ft. The area of the water section is 2 x 5 plus 0.01 x 10 = 10.1 sq.ft., and the mean depth is $\frac{a}{t} = \frac{10.1}{10} = 1.01$ ft. By the formula the velocity head should equal one-half the mean depth or $\frac{1.01}{2} = 0.505$ ft. $= \frac{v^2}{2g}$. The critical velocity, therefore, should be $\sqrt{0.505 \times 64.4} = 5.7$ ft. per second and $Q = Va = 5.7 \times 10.1 = 57.5$ sec.-ft.

It would seem then that 57.5 sec.-ft. must be the critical flow for 2.01 ft. (total depth) or 1.01 ft. (mean depth) and that the sum of the depth and velocity head 2.01 (total depth) + 0.505 = 2.515, or 1.01 (mean depth) + 0.505 = 1.515 must be a minimum value as the conditions of the formula, velocity head = one-half mean depth appear fulfilled.

This, however, is not true, as will be found by taking the depth as 2 ft., thus making the top width = 5.0 ft.; the sum of the depth and velocity heads in this case for Q = 57.5 sec.-ft. is slightly less than when the depth is 2.01 ft. It will also be found that the correct critical depth for Q = 57.5 sec.-ft. is 1.6 ft. and the corresponding velocity head is about 0.80 ft., their sum being 2.40 ft. which is a minimum, as will be seen by plotting the depth (total) plus velocity head curve. From this it appears that 57.5 sec.-ft. is not the critical flow for a depth of 2.01 ft.

The equation given by Mr. Hinds, $\frac{a^3}{t} = \frac{Q^2}{g}$ (*Engineering News-Record*, Nov. 25, 1920, p. 1039) is a help in this case, as by taking t as 5 ft. and then as 10 ft., two critical depths can be found and the one which shows the smaller value of total depth plus velocity head gives the correct result. With t = 5 ft. the mean depth is the same as the total depth, but with t = 10 ft. the mean depth and total depth have different values, and after finding the mean depth by the above equation, the total depth should be added to the velocity head to compare for minimum value with the case where t = 5 ft.

Taking Q as 70 sec.-ft., it is found that there are two depths which have nearly the same value for the sum of the total depth plus velocity head, the velocity head equaling one-half the mean depth in each case. Using t = 10 ft. the critical depth is found to be 1.15 ft. (mean) or 2.15 ft. (total); the velocity is 6.09 ft., and velocity head is 0.575 ft. Total depth plus velocity head is 2.725 ft. Using t = 5 ft. the critical depth is 1.83 ft.; the velocity is 7.68 ft.; the velocity head is 0.915 ft. and depth plus velocity head is 2.745 ft. As 2.725 is the lesser value, it indicates that the true critical depth for Q = 70 sec.-ft. is 2.15 ft. (total) or 1.15 ft. (mean).

Taking $Q = 60$ sec-ft. it is found that the critical depth is 1.64 (mean same as total). Taking $Q = 80$ sec.-ft. the critical depth is found to be 2.26 ft. For each of these values of Q, there is another depth which will satisfy the formula before mentioned but which does not give the minimum value for depth (total) plus velocity head.

In changing from $Q = 60$ sec.-ft. to $Q = 70$ sec.-ft. the critical depth rises 0.50 ft. and also out of the $t = 5$ ft. section into the $t = 10$ ft. section. In changing from $Q = 70$ sec.-ft. to 80 sec.-ft., the critical depth rises only 0.11 ft., and this change occurs, of course, in the $t = 10$ ft. section.

Further analysis may perhaps show what the conditions are which keep the actual critical depth in the $t = 5$ or the $t = 10$ ft. sections.

If Q were taken as 100 sec.-ft. and $t = 10$ ft., it would be found that the critical depth would be 2.46 ft. (total depth), the area being 14.6 sq.ft., the mean depth 1.46 ft. and the velocity head about 0.73 ft. which checks with the formula. Taking $t = 5$ ft. gives a result which would be impossible, the area being more than 10 sq.ft.

In conclusion, I agree with Mr. Stevens' finding regarding any open channel, that, "For critical flow the velocity head is one-half the mean depth" but wish to supplement this by the following statement:

In an open channel of the form illustrated above, and other similar sections, for some values of Q the velocity head may equal one-half the mean depth without indicating critical flow.

FRANK S. BAILEY,
Assistant Engineer, Metcalf & Eddy.

Boston, Mass.
March 1, 1927.

Sir—The channel illustrated in Mr. Bailey's letter of March 1 is a typical case of overflow. Wherever portions of a channel have widely different velocities, they should be treated separately whether one is dealing with critical flow or with the usual slope formulas.

The analysis in my original article (*Engineering News-Record*, June 4, 1925) is predicated on properly determined mean velocities and particular attention was called to the limitations of accuracy thereby attainable.

In such "freak" channels as that cited the mean velocity is not properly found by dividing the total flow by the total area. If one turned a fire stream into the ocean he would hardly think of dividing the discharge of the fire stream by the area of the ocean to obtain the mean velocity.

Nevertheless such "freak" channels may be dealt with. Imagine a channel composed of n portions in each of which the mean velocity is properly determined by dividing the flow therein by the area. We may consider the water boundaries as vertical lines and neglect friction of water on water at these boundaries.

The total energy of the flowing water is

$$Qe = q_1 e_1 + q_2 e_2 + \ldots q_n e_n$$

whence

$$e = \frac{1}{Q}\left[q_1\left(s + \frac{v_1^2}{2g}\right) + q_2\left(s + \frac{v_2^2}{2g}\right) + \ldots q_n \left(s + \frac{v_n^2}{2g}\right)\right]$$

where Q is the total flow and s is the common elevation of the water surface.

If the first derivative with respect to s of this expression be placed equal to zero, we obtain the condition for minimum total energy, and there results

$$Qg = v_1^3 t_1 + v_2^3 t_2 + \ldots v_n^3 t_n$$

where t is the top width of each portion considered.

This equation can only be solved tentatively, but the solution is greatly simplified by first assigning an arbitrary slope to such a channel and computing the flow in each portion for any given value of s. Then maintaining that value and with it the same depths, areas, hydraulic radii, etc., consider the slope steepened (or flattened) until a value of Q is found that will satisfy the equation.

For the channel cited by Mr. Bailey critical flow for a depth of 2.2 ft. in the deep portion of a depth of 0.2 ft. in the overflow portion results with a flow of 95.2 sec.-ft. This result is independent of the roughness of the channel, although to maintain critical flow the channel must have a slope of 0.0057 if the Kutter coefficient $n = 0.015$ or a slope of 0.0106 if $n = 0.02$, etc. If the channel be considered as a whole, the mean depth is 1.2, the mean velocity head is 0.98, which is considerably in excess of one-half the mean depth. Considering such a channel as a whole, however, is meaningless.

Mr. Hinds' equation (*Engineering News-Record*, Nov. 25, 1920, p. 1039)

$$\frac{a^3}{t} = \frac{Q^2}{g}$$

is identical with equation 11 in my original article,

$$\frac{v^2}{2g} = \frac{a}{2t} = \frac{1}{2}d_c$$

as is obvious since Q^2 may be replaced by a^2v^2.

J. C. STEVENS.
Portland, Ore.,
March 23, 1927.

For More Private Toll Bridges

Sir—Referring to the editorial "A Toll Bridge Fallacy" in your issue of Feb. 10, 1927:

Whether or not one includes toll bridges in the same class as other public utilities, the fact remains that the toll bridge performs a useful and valuable public service. The very fact that the number of such bridges is rapidly increasing shows that there is a demand for such structures from the standpoint of public convenience and necessity. If there is such a demand, and the public does not feel inclined at present to use public money for expensive bridge construction, private capital will be available under assurance of adequate returns and proper protection of the original investment. If requirements for a franchise to construct any such bridge are too severe, the structure cannot be financed, and the public will not realize the advantages due to the river crossing. If there is a demand for an expensive major stream bridge, and if it would be a public convenience and aid, it is much better business policy to make the terms attractive and get the bridge than to restrict the franchise terms and continue to use a ferry, or have no crossing whatever for perhaps a long period of time.

Thirty or forty years ago many privately owned highway bridges were built by private initiative; most of these it is safe to say paid no returns to their owners until the automobile developed and made a demand for their use. These structures have depreciated and required in many cases reconstruction at great expense to their owners. These men were undoubtedly performing a great public service to the communities in the early 80's and 90's, and took the risk when the public was unwilling to embark on such an adventure.

Major stream bridges require large sums of money. Most people prefer to see all public money that is available spent on paved roads to first get out of the mud. Two million dollars of public money spent on a bridge a mile long would build from 80 to 100 miles of concrete road, and any sane person would say the public money was better spent if put into the roads, if the roads needed it, rather than spent in a single bridge. "Public convenience and necessity" would be better served by such a decision, leaving the bridge structure to be provided by private capital, under terms which would assure the owners a fair return and protection of their original investment. Any other terms or restrictions would defeat the very purpose for which they might be drawn in that no one would undertake to make the investment and assume the risks involved.

The investment in a private toll bridge is even now one of considerable risk. A bridge in itself is not a unit entirely free from any hazards, as we all know. There is constant agitation for "free" bridges, people naturally want something for nothing if they can get it, even to the extent on the part of politicians of using tactics which appear to threaten confiscation of one's investment. One is not assured that the use of the automobile will not decrease somewhat as years go by, from advancing costs of motor fuel due to dwindling supply caused by enormous present demands, and other unforeseen changes. The user of an expensive bridge theoretically should pay for the service given, to cover costs of upkeep, interest, taxes, depreciation, including a fair return to the owners. It is not quite necessary to give such service free to users of a large bridge when the users of our public roads in most states pay a toll (gasoline tax) to use the roads. In driving over 100 miles of road he pays from 10c. to 15c. for the use of the road.

The toll bridge wherever located is a utility which should be appreciated by the users of the service. The owners are providing a distinct public service. We would all much

rather pay to cross a stream on a bridge than use a ferry, and the construction of such bridges should be encouraged where there is demand for such service.

It would seem that the best policy would be to use available public money first on "good roads" and get out of the mud, before constructing so-called free bridges. If a tourist had his choice he would take the good roads leading to a toll bridge in preference to bad roads leading to a "free" bridge.

R. H. FINDLEY,
Chief Engineer, Omaha & Council Bluffs Street Railway Co.

Omaha, Neb.,
March 11, 1927.

Three-Lane Highways Urged for War

Sir—The receipt of your annual special highway issue brought to mind a matter which I have for some time felt should receive serious consideration from the authorities in charge of road work throughout the country.

With some few exceptions, the average road is installed to carry but two lines of traffic, allowing for liberal clearance. It is my personal opinion that the width of the roadway should be so increased that three lines, at a minimum, could be handled. Anyone who is at all familiar with the question of supply, or who witnessed the traffic of the armies in France during the recent war, could not help but appreciate the importance of roads. In fact, it might be said that the lack of sufficient roads for motor transportation would prohibit proper supply of any army, which at the best is a difficult problem.

I realize that while the present-day popular tendency is to take the stand that war will be outlawed, there are many of us who feel otherwise, and I would like to see some preparations made against a possible invasion of the country. Good roads, together with many other things, cannot be produced overnight, and I feel that serious consideration should be given to the possible future military, as well as commercial, requirements of the highways being constructed throughout the country.

R. S. TILDEN.

New York, N. Y.,
Feb. 15, 1927.

Priority in Four-Lane Flexible Paving Slabs

Sir—It was with considerable astonishment that I noted in *Engineering News-Record*, March 3, 1927, p. 361, the description of a four-lane highway separated by parting strips, with the claim made that this cross-section was a new development initiated in Wisconsin.

By a curious coincidence, this article appeared exactly a year after the description of the Woodward Ave. superhighway out of Detroit, on which an exact duplicate of this cross-section occurs with the exception of the use of dowel bars, which was discarded by this department some years ago. Plans for this pavement were prepared in 1923 and the major part of the construction took place during 1925, but even at that time no claim was made by the Michigan State Highway Department that this construction was novel. A similar cross-section has since been used as our standard on streets and pavements wider than 20 ft.

You will note that a picture on p. 352 of the March 4, 1926, issue of *Engineering News-Record*, gives exactly the same kind of a view as shown in the March 3, 1927, issue, in which the tarred parting strips are plainly visible. Editorial comment states that this "design has been worked out with care and is interesting in itself." This is perfectly true, but it was hardly to be expected that the cross-section of so widely advertised a highway as Wider Woodward should be exploited as novel exactly a year after a published description of the identical cross-section. The insertion of dowel bars at the joints and the use of 4-ft. transverse dowels instead of 5-ft., in our opinion, hardly constitutes a novel departure from the Woodward Ave. design.

G. C. DILLMAN,
Deputy Commissioner-Chief-Engineer,
Michigan Highway Department.

Lansing, Mich.,
March 8, 1927.

[It seems quite clear from Mr. Balsley's article that his thought was to assert merely that the pavement design described had been newly used in Wisconsin. The editorial made no reference to priority of design or construction, but turned on the possibility of this and other similar jointed-slab designs indicating a change in the trend of practice.—EDITOR.]

Shore Protection Structures

Sir—Referring to the editorial "Voracious Ocean" in *Engineering News-Record*, March 10, p. 390, it seems to be the belief of New Jersey and Long Island coast resorts as well as "land development companies" that groins and bulkheads of timber, loose rock or combinations of these materials afford sufficient protection. No doubt protective structures of these materials are better in most cases than no protection, but why municipalities and states waste as much money on such devices, giving at the best but temporary partial protection, as it would cost for absolute protection, is a puzzle.

By absolute protection against erosion is meant: A system of structures that, in addition to having known and tested elements of the desired function, is permanent, impregnable to ocean forces and an absolute protection of shore involved *against contact* with destructive forces of the ocean.

The force of wave impacts has been measured and is known; the height of a wave is limited by the depth of water and the ratio is known; and littoral sand drift and local hydrographic conditions can be ascertained. Therefore, an absolute protective device can be designed based on engineering principles. On the West and Gulf coasts the step-type sea wall of reinforced concrete has been developed and has proved effective.

The step type sea wall was developed in Holland, then improved upon in the United States. It is accepted by beach protection authorities as an effective type. It breaks up the waves. They do not rebound as from vertical walls, tearing out the beach in front of them. I believe it is the most economic permanent impregnable type to build. Such walls are built watertight, with the sea face supported on reinforced-concrete sheetpiles and the back by concrete piles. The wall in turn is protected from scour by groins at right angles to the wall, preferably of reinforced concrete. The groins also tend to induce accretion during favorable weather.

Such a system of structures properly designed is not susceptible to heavy damage at high tides and during storms as that of Feb. 20, nor are they eyesores as are the loose rock and combination types of sea walls. As this type has given excellent results where used it seems reasonable to advocate construction of such structures on the Atlantic coast.

I am a railroad engineer, but an interest in beach preservation took me to Europe to study methods practiced there as well as those in this country. In my opinion shore preservation methods at places in the United States are more advanced than in Europe. The Atlantic coast resorts are not taking advantage of the progress that has been made on either continent.

H. V. CAMPBELL,
Civil Engineer.
(Formerly Assistant Chief Engineer, Manila R.R. Co.)

Freehold, N. J.,
March 12, 1927.

License Laws to Exclude Incompetents

Sir—In your issue of Feb. 10, p. 250, I noticed an article on licensing engineers, signed by several gentlemen from St. Louis, in which the statement is made that "laws cannot make the public call a man an engineer when he isn't, nor help an incompetent man hold down a job," or words to that effect.

If this is the purpose of licensing engineers, I have misunderstood the whole theory of the proposition.

My understanding of these laws is exactly opposite—that they are to prevent incompetent, insufficiently-prepared men, with a slight smattering of engineering training, say what a good rodman picks up, from styling themselves as engineers, and by using the gift of gab, and a little politics, holding positions which should be filled by a technically-trained man.

Probably every practicing engineer could name a few doing this at any time. The public in general seems to know so little of what an engineer is that these men have an easy time getting away with this, and, as I understand the licensing laws, they are to protect the public and the profession from this practice.

A. O. BOSSHARD.

Eau Claire, Wis.,
Feb. 18, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

New Jersey Interferes with Port Authority

Passes Law Giving State Commission Power to Pass on All Port Authority Contracts

Possibilities for a long delay in the start of construction of the proposed bridge across the Hudson River at New York are contained in a bill passed by the New Jersey legislature and signed by the Governor. It also may affect the completion of the two interstate bridges now under construction across Arthur Kill and a third proposed across Kill Van Kull, all either being built or to be built by the Port of New York Authority.

The bill in question provides that all of the port authority contracts must be passed upon by the New Jersey State House Commission, a commission made up of the governor, controller, and treasurer.

The compact which was made between the two states to set up the port authority provided that each state might, by legislation, provide that its governor could veto the action of any commissioner appointed to the port authority from that state. Such a provision was written into the present bill when introduced in the New Jersey legislature, but during its passage it was altered to read that the State House Commission was to pass upon all contracts of the port authority. In view of the action of the New Jersey legislature the New York legislature passed a bill giving the governor the powers provided in the interstate compact. Governor Smith is expected to sign it in view of the action of the New Jersey governor.

Reason for Action

Reason for the action of the New Jersey legislature according to the chairman of the port authority, is due to the fact that the legislature had been led to believe that the engineers of the port authority were committed to the use of eye-bar suspension for the Hudson River bridge in preference to cables. As one of the large makers of cables in the country (John A. Roebling's Sons Co.) is located in New Jersey, the state legislature saw New Jersey losing a contract if cable suspension was eliminated.

On the matter of type of suspension to be used, the chairman of the port authority said that when the specifications for the bridge are drawn they will provide every opportunity for the broadest kind of competitive bidding in order to secure the best work at the lowest prices.

With the passage of the New Jersey law, all work on the port authority bridges except that under contract will be delayed until a test case can be taken to the Supreme Court for a decision on the constitutionality of the New Jersey law.

N. Y. State Legislature Kills Power Authority Plan

The New York State legislature has adjourned without passing the bill sponsored by Governor Smith for the establishment of a power authority to undertake the development of water power resources of the state which are not controlled by private interests. Also, it failed to pass another bill providing for a referendum on state or private development of water power.

Am. Soc. C. E. Spring Meeting Program Announced

Streams as sources of water supply will be the subject of discussion at the first technical session of the spring meeting of the American Society of Civil Engineers to be held at Asheville, N. C., April 20-22. This session will be the morning of April 20, and in the afternoon a students' conference will be held. At this session Robert Ridgway will give an illustrated lecture on the New York subways. Following this will be five-minute talks by nine students from as many southern colleges, a question box, general discussion of student chapters, society affairs, the civil engineering profession, etc.

Division mettings will be held on Thursday, April 21, morning, the construction division to hold a symposium on textile mills in the South; the power division to consider "Re-Designing the Catawba Station for Service on a Large Transmission System"; and the sanitary engineering division to hear papers on "Water Supply and Sewerage for the Lake Lure Development near Asheville" and "Experiments on the Pulverizing of Sewage Screenings at Baltimore."

The third technical session will be held Friday morning when the following three papers will be presented:

"Foundations and Drainage of Highways." "The Design, Construction, and Advantages of Bituminous Highways." "The Design, Construction, and Advantages of Concrete Highways."

Points of interest which will be visited include Chimney Rock and Lake Lure and the Bridgewater Station of the Southern Power Co.

Ridgway, Talbot, Galloway for Bay Bridge Study

The San Francisco board of public works on March 23 announced that Robert Ridgway, New York; A. N. Talbot, Urbana, Ill., and J. D. Galloway, San Francisco, had accepted appointment on the board of engineers that is to study and report on the several San Francisco bay bridge projects for which franchise applications have been made. The resolution that authorized the selection of three engineers from a list submitted by the presidents of four local universities specified that a report was to be prepared within a 30-day period. Previous reference to the selection of these engineers appeared in *Engineering News-Record*, March 17, p. 462.

Record Attendance at N. J. Sewage Works Meeting

Association Will Publish Quarterly Journal—May Hold Two-Day Sessions Hereafter

Attendance records were broken at the twelfth annual meeting of the New Jersey Sewage Works Association, held at Trenton, March 25. The one hundred members and guests present included a goodly number from other states, the membership list now including representatives from a dozen or more states widely distributed throughout the country. The association voted to publish what in effect will be a quarterly journal containing not only the papers read before the association, but also those read before similar bodies affiliated for the purpose of joint publication. A proposal to hold two-day sessions hereafter, one day to be devoted to matters of chief concern to plant operators, and the other to research papers and discussions, was referred to the executive committee. All the officers of the association were re-elected, including the president, P. N. Daniels, city sanitary engineer, Trenton, and the secretary, John R. Downes, superintendent Plainfield joint sewage-works, Bound Brook.

Half a dozen papers were read and discussed at the first or afternoon session which followed an inspection trip to the Trenton sewage-works and a luncheon. In the evening, the report of the research committee, which had been presented in the afternoon by Wellington Donaldson, and discussed by Dr. William Rudolfs, chief of the New Jersey Sewage Experiment Station, New Brunswick, was again up for consideration together with various research topics. Most of the time given to research discussions was occupied by Dr. Rudolfs in his review of the work at his station, including the subject of trade wastes and their relation to sludge digestion tanks. A paper on trickling filters, by A. M. Buswell, director, Illinois State Water Surveys, was also presented at the evening session.

Among the other papers was a notable one by I. R. Riker, senior sanitary engineer, State Department of Health, on the "Effect of Laundry Wastes on a Small Sewage Disposal Plant," at Oaklyn, N. J. These wastes caused tank foaming and were finally cut off from admission to the sewerage system, whereafter the laundry went out of business.

Typhoid Outbreak at Montreal Attributed to Milk

Some 1,200 cases of typhoid fever were reported to the health authorities of Montreal, Que., between March 4 and noon on March 26, compared with 19 cases from Jan. 1 to March 3. New cases for the 24 hours ending at noon, March 26, numbered 124, the highest daily total that far. The outbreak is attributed to milk. On March 28 the United States placed an embargo on the importation of Canadian milk produced within 200 miles of Montreal.

Fate of Delaware River Compact Still Uncertain

Up to the close of its main session, March 25, the New Jersey Legislature had not acted on the pending Tri-State Delaware River Compact, which has been adopted by the New York Legislature but is still before the Pennsylvania Legislature. Before its temporary adjournment the New Jersey Legislature appointed a joint committee to confer with the Pennsylvania authorities as to their action on the compact and their willingness to accept an amendment which would increase the minimum flow of water to be maintained in the New Jersey-Pennsylvania portion of the river. Should this conference result in an agreement, and possibly even if it does not, there is hope that when the New Jersey Legislature convenes for its final session, the latter part of the present week, it may adopt the compact.

If the compact as submitted to the three legislatures is amended by the New Jersey and Pennsylvania legislatures it will have to go before the New York Legislature again. This would occasion no material delay should it be included in a call for a special session of the New York Legislature to remedy defects in action on a resolution for a referendum to vote on a constitutional amendment authorizing an executive budget in New York State. Besides passing the tri-state compact, the New York Legislature appropriated $10,000 for the study of New York-New Jersey interstate water problems other than those pertaining to the Delaware, chiefly concerning the Hackensack and Ramapo rivers.

Bridge From Long Island to Mainland Proposed

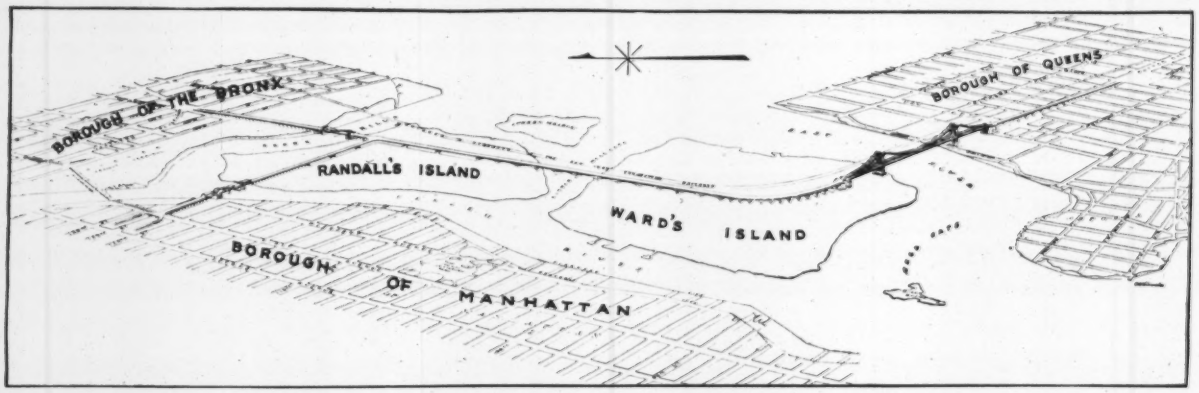
Design of Structure to Cost, All Told $27,435,000, Is Submitted to N. Y. Estimate Board

Plans for a highway bridge from the west end of Long Island, N. Y., across Hell Gate in the East River, to Wards Island and across Little Hell Gate to Randalls Island and thence across Bronx Kill to the mainland, with a branch from Randalls Island across the Harlem River to Manhattan Island, have been presented to the Board of Estimate of New York City by the Commissioner of Plant and Structures. The bridge is designed to facilitate the movement of traffic from the mainland and upper Manhattan Island to Long Island City by diverting it from the congested streets on Manhattan and from the present East River bridges. The proposed bridge, known as the Triborough bridge, will have its Long Island terminal in Astoria, in the Borough of Queens, its Manhattan terminal at 125th St., and its Bronx terminal at Cypress Ave. and 134th.

As now planned, the bridge will have a length of 12,700 ft. with an additional 4,150 ft. in the Manhattan connection. The main bridge will have two 36-ft. roadways providing for eight lanes of traffic and the Manhattan connection will have a width of 53 ft. for six lanes of traffic. The Hell Gate crossing would be a suspension span of 1,100 ft. having a vertical clearance above mean high water of 135 ft. A drawbridge having a clearance of 50 ft. will be built over the Harlem River and provision for a similar opening will be made at Bronx Kill. Earth fill and steel arches will be used for the viaduct over the island and for the higher portions of the approaches. The suspension bridge is designed as two parallel bridges with 36-ft. roadways, with the idea that only half the bridge may be built at first.

The estimated cost of the bridge is $22,000,000, land for the approaches $2,810,000, $1,125,000 for damage to city buildings on the two islands, and $1,500,000 for contingencies; a total of $27,435,000.

The bridge will be approximately parallel to that of the N. Y. Connecting R.R.



PROPOSED HIGHWAY BRIDGE OVER THE EAST RIVER AT NEW YORK

Large Additional Water Supply Advised for Rochester, N. Y.

An additional water supply for Rochester, N. Y., to be obtained by raising Honeoye Lake and laying a gravity steel conduit therefrom to the Cobb's Hill reservoir is recommended in a report made by Allen Hazen, New York City, Harrison P. Eddy, Boston, and Edwin A. Fisher, Rochester. The ultimate cost of the improvement would be $22,000,000 but $12,000,000 would suffice for the present. The larger outlay would provide water for a million people.

University Credit Now Given Westinghouse Employes

The University of Pittsburgh has agreed to give full academic recognition to certain educational activities carried on by the Westinghouse Electric and Manufacturing Co.

By this agreement, reached recently, certain features of the Westinghouse educational program are to be identified with the graduate school of the university and certain Westinghouse engineers are to be given regular university appointments as lecturers.

Applied to the Westinghouse employees, whose registration for the course already has been approved, the plan means tbat they will be given 15 resident university credits for work done with the Westinghouse company. Since at least 24 resident credits are required for any degree at the university, the Westinghouse student will have a minimum of nine credits to obtain through actual scholastic work in the night school. The course leads to degrees of master of science, or doctor of philosophy. Westinghouse employees studying technical subjects in the research department or in the various shops of the company are eligible. At the university the men chiefly responsible for this agreement are Chancellor John G. Bowman, Dr. Lee Paul Sieg, dean of the graduate school and Dr. Frederick Lendall Bishop, dean of the schools of engineering and mines, and secretary of the Society for the Promotion of Engineering Education. C. S. Coler, Westinghouse educational director, and Dr. Emerson B. Roberts of the same department, perfected the industrial phase of the co-operative plan.

Control of Bathing in New Jersey Water Supplies Annulled

A bill declaring it to be lawful to bathe in any of the fresh waters of New Jersey, provided no trespass is committed, was enacted in the closing days of the legislature, vetoed by the governor and passed over his veto. Outside the representatives from Jersey City and other Hudson County districts the vote for the bill on both original passage and repassage was almost if not quite unanimous. The bill that passed was the shorter of two printed in *Engineering News-Record*, March 10, 1927, p. 423, each of which was designed primarily to annul a recently adopted "amendment" or addition to the State Sanitary Code of the State Board of Health (printed in full, *Engineering News-Record*, Dec. 16, 1926, p. 1012). The amendment followed a lengthy agitation, particularly by Jersey City, to get state action to stop bathing in sources of public water supply. Bills to that end having met death in successive legislatures, pressure for action by the State Board of Health resulted in the amendment already mentioned. Bathing and other resort owners, real estate developers and individual land owners on the shores of streams and lakes who unsuccessfully opposed the adoption of the amendment organized for its annulment by the legislature and won.

Fire Protection Association Plans War on Fire Waste

Faced by the growing economic burden imposed by fire waste, a group of prominent business leaders throughout the country are organizing a concerted attack on the fire menace. A statement of the plan has been issued by Irving T. Bush, president of the Bush Terminal Co., and national chairman of a committee of representative men which is raising a fund of $500,000 with which to finance the fight on fire.

When this fund is obtained, ten skilled fire prevention engineers will operate for the next five years wherever the local loss record indicates that fire conditions should be remedied. Supervised by the National Fire Protection Association, which has made a scientific study of fire causes for the past 31 years, these men will work through local fire prevention agencies and civic organizations.

During the past two years this Association has sent out two fire prevention engineers as an experiment to determine what could be accomplished by field work. The fight against fire has been carried to eighty different localities so successfully that with ten field engineers operating under the same plan of getting cities to protect themselves fire losses can be cut down from 25 to 50 per cent within five years, Mr. Bush stated.

Lammot du Pont, president of the E. I. du Pont de Nemours & Co., is honorary chairman of the campaign; Mr. Bush is national chairman, and Edward J. Mehren, McGraw-Hill Publishing Co., Inc., national vice-chairman. Members of the advisory committee are Joseph H. Alexander, president of the Cleveland Ry. Co.; W. W. Atterbury, president of the Pennsylvania R.R. Co.; S. L. Avery, president of the U. S. Gypsum Co., Chicago; Julius H. Barnes, president of the Barnes-Ames Co.; J. B. Book, Jr., president of the Book Development Corporation, Detroit; Walter S. Bucklin, president of the National Shawmut Bank, Boston; Nicholas Murray Butler, president of Columbia University; Newcomb Carlton, president of the Western Union Telegraph Co.; Howard Coonley, president of the Walworth Co., Boston; Philip H. Gadsden, vice-president of the United Gas Improvement Co., Philadelphia; R. C. Holmes, president of the Texas Co.; F. W. Lovejoy, vice-president of the Eastman Kodak Co.; Edwin G. Merrill, president of the Bank of New York and Trust Co.; Henry D. Sharpe, treasurer of Brown and Sharpe Co., Providence; Alfred P. Sloan, Jr., president of the General Motors Corporation; S. W. Stratton, president of Massachusetts Institute of Technology; Ralph Van Vechten, president of the State Bank of Chicago; John R. Washburn, vice-president of the Continental and Commercial National Bank of Chicago; Bertram G. Work, president of the B. F. Goodrich Co.

Engineering Fifty Years Ago

From *Engineering News*, March 31, 1877

ALL the anchorages of the Suspension Bridge, Niagara Falls, have been opened, and with the exception of the first one, have been found in good condition. The repairs that have to be done are now completed, and the passenger traffic will be resumed as soon as a certificate of the safety of the bridge can be obtained from three of the most able engineers of the day.

Changes on New York West Side Advanced by Legislation

The New York State Legislature, before it adjourned, passed two bills affecting the New York Central tracks on the west side of Manhattan Island above 72nd St. One bill provides for the exchange of small parcels of land between the city of New York and the railroad company in connection with the grade separation work being carried on before 125th St., and the other bill provides for the proposed West Side express highway over New York Central yards when that structure is built.

The two bills have no bearing upon the elimination of the railroad company's tracks from streets below 60th St., where the tracks run at grade. Both bills are concerned with work above that point and the one concerning the express highway applies to changes to be made through its construction over the railroad yards at 60th St.

New York Provides $2,000,000 for Kill Van Kull Bridge

The Bayonne-Port Richmond bridge finance act has been signed by Governor Smith of New York. The bill provides for the payment by the state of New York to the Port of New York Authority of five annual installments of $400,000 each towards the construction of a bridge from Port Richmond, on Staten Island, to Bayonne, N. J. The bridge, which is to be a steel arch structure of 1,650-ft. span, was described in *Engineering News-Record* of Feb. 17, p. 284. It is to be built for highway traffic.

The New York State bill does not become effective until the New Jersey Legislature appropriates a like amount. The total estimated cost of the bridge is $16,000,000. The amount in excess of the $4,000,000 to be provided by the two states is to be obtained from the sale of Port Authority bonds.

Columbia River Bridge Hearings Occupy Five Days

Proponents and opponents of the plan of a private company to build a toll bridge across the Columbia River between Rainier, Ore., and Longview, Wash., presented their views before federal officials at hearings in Portland and in Longview that lasted five days and were concluded on Mar. 19. These hearings were held in accordance with an act of Congress of Jan. 28 which granted a franchise for the bridge conditioned upon the approval of three cabinet members, namely, the Secretaries of Commerce, Agriculture and War. These three departments of the federal government were represented at the hearings respectively by E. Lester Jones, director of the U. S. Coast and Geodetic Survey; Thomas H. MacDonald, chief of the Bureau of Public Roads, and Major R. T. Coiner, U. S. A. Engineer Corps. No decision will be announced until these reports have been considered at Washington.

Promoters of the project said that increasing traffic created a demand for auto ferries that would be a greater menace to shipping than bridge piers. Navigation interests, generally speaking, were averse to any bridge that would afford horizontal clearance less than 1,000 ft. C. B. McCullough, bridge engineer of the Oregon State Highway Commission, testified that studies extending over a period of years had led to a selection by the commission of the preferable bridge site at Coffin Rock, where for a cost of $4,600,000 a bridge could be constructed with a vertical clearance of 190 ft. and horizontal clearance of 1,400 ft.

New York to Vote on Millions for New City Subways

The New York legislature has approved submitting a constitutional amendment to the voters of the state this fall which will extend the debt limit of the city of New York $300,000,000 to provide funds for the extension of the city's subways.

Reagan Now on Los Angeles Flood-Control Consulting Board

J. W. Reagan has resigned as chief engineer of the Los Angeles County Flood Control District and E. Court Eaton, his assistant, has been appointed acting flood-control engineer. The board of supervisors has appointed to advise the flood-control district a board of consulting engineers consisting of J. B. Lippincott, Charles H. Paul and J. W. Reagan.

Third Short Course for Oklahoma Water-Works Men

The third Oklahoma short course for water-works and filter plant operators opened at Stillwater on March 27 and will continue until April 2. It is conducted under the auspices of the department of vocational education, the board of health, the water-works conference and the Oklahoma Agricultural and Mechanical College. The instructors are H. J. Darcey, engineer, state board of health; Martin E. Flentjo, chemist, Oklahoma City Water Department; E. H. Harndon, bacteriologist, A. & M. College; Rudolph Hassler, chemical engineer; O. G. Hazel, bacteriologist, state board of health; O. M. Smith, chemist, A. & M. College; and E. R. Stapley, engineer, A. & M. College.

State Court of Appeals Upholds Baltimore Zoning

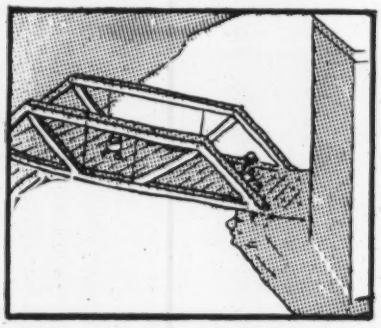
The validity of the zoning ordinance of Baltimore, Md., has been upheld by the Maryland Court of Appeals in a decision sustaining the Baltimore City Court. Two of the justices voted adversely. The case was brought as a mandamus suit to compel the granting of a permit to build 16 two-story dwellings in a continuous row on an avenue zoned for single houses. According to a press despatch the Court of Appeals stated that it "upheld the earlier decision because in its opinion the appellant did not provide for side yards, as required by the zoning ordinance. This provision of the ordinance was declared to be 'promotive of the public safety, health and morals by preventing an increase in the population and thereby reducing fire and traffic hazards and giving more light and air and improving the living conditions of the people.'"

San Francisco to Vote on Water Supply System Purchase

The board of supervisors of San Francisco on March 21 gave final approval to a bond election for $40,000,000 with which to purchase the Spring Valley Water Co.'s system. The properties are wanted to provide local storage reservoirs and a distribution system for the water supply to be brought in by the city's Hetch Hetchy water supply project. The date for the bond election was not definitely set but is expected to be not later than June.

The supervisors also adopted a resolution of policy declaring that the water system "should be placed under the jurisdiction of a Public Utilities Commission" * * * "to have charge and control of the operation, maintenance and conduct of all the properties acquired from the Spring Valley Water Co." The supervisors promise to submit to the electors not later than November next an amendment to the city charter, providing for the creation of such a public utilities commission.

Another One of Those



Random Lines

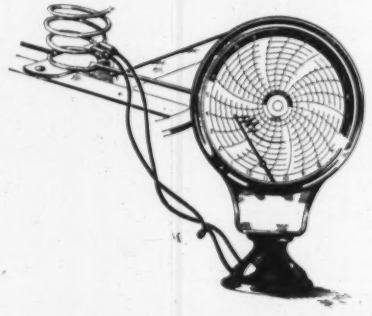
Et Cetera, Et Cetera!

(220) *Preservation Engineers* — Who work for the Southern Wood Preserving Co.

(221) *Dehorning Engineer* — "Several years ago," says a correspondent, "in western Missouri it became a fad to remove the horns from all of the cattle. Several persons became expert at this work but one finally obtained nearly all of the business by advertis- himself as a 'Dehorning Engineer.'"

(222) *Sign Engineer*—Drop a line to Frank E. Cheney, of Boston, and one of them will come to see you about your outdoor advertising problems.

(223) *Sleep Engineers*—The experimenters of the Blue Ribbon Bed Co., who have proved beyond all peradventure of a doubt that their particular breed of helix



insures a maximum of relaxation, in spite of the contentions of a competitor, the Union Bed & Spring Co., which by the device shown herewith put the bee on such unsupported claims. It will be noted that the testee did his sleeping just after lunch.

* * *

American Contractors Wanted for Road Work in Brazil

The congress of Brazil has passed a highway bill appropriating 15,000 contos (about $1,800,000) for road building during 1927, and providing for a permanent appropriation each year thereafter for that purpose. In reporting this action, the Department of Commerce announces that no indication has yet been given as to how this work will be done, other than that the government is authorized to co-operate with the state governments with regard to financing the work. It is probable that the federal government will attempt to have the state governments provide something toward the building of roads in their respective states, or, in other words, the federal government will try to establish a federal-aid system similar to that in the United States. The federal government will, undoubtedly, favor national companies despite the fact that, in most cases, this results in higher cost to the government than if the contracts were granted to qualified foreign concerns. Nevertheless, it is probable that foreign firms will actually do a large part of the work, since the usual practice is for the national companies to secure contracts and sublet them to firms more capable of carrying out the work.

The assistant commercial attaché at Rio de Janeiro requests that the large American construction companies which handle such work and which do not have representatives in Brazil, advise his office of their interest so that they can be placed in touch with Brazilian concerns in a position to secure some of the contracts to be let. One such Brazilian concern, Almeida Lisboa & Cia., Rua Buenos Aires 59 (representing Brown Boveri, of Switzerland, etc.), would like to be placed in touch with American construction companies financially and technically able to do work of this sort. Dr. Almeida Lisboa has personal contact with the President, and is positive that if he has the proper American backing he will be able to gain road building contracts which he would sublet to his American connections. Of course, it would be preferable if the American firms could secure these contracts direct, but as these things are not usually handled in that manner, the next best thing is for the American firm to obtain the contracts through influential Brazilian firms.

Railway in Ontario Completed

The Spruce Falls Power and Paper Co. has completed the 50-mile railway line it has had under construction to the Smoky Falls power site on the Kapuskasing River, in Northern Ontario.

Quebec Railway to Be Extended

Before the end of 1927 the railway line to complete the circuit around Lake St. John, in the province of Quebec, will be built, according to a recent statement by Premier Taschereau. The provincial government has voted a subsidy of $567,000. The Dominion Government is expected to vote a subsidy.

Personal Notes

H. C. FRAHM, until now state engineer of North Dakota, has been appointed chief engineer of the State Highway Commission, following a reorganization of this commission.

L. C. WEST has been made chief engineer for the Union Structural, Inc., Syracuse, N. Y. Mr. West was previously associated with William R. Davis, consulting engineer, Albany, N. Y., and still earlier was an assistant engineer in the New York State engineering department, for thirteen years.

L. T. MARTIN has been appointed vice-chairman of the Temiskaming & Northern Ontario Ry., of which he was appointed commissioner in 1921. Colonel Martin was for many years prominent as a railway contractor. While overseas he commanded the 7th Battalion, Canadian Railway Troops, and he was identified with the construction of railway lines on the French and Belgian fronts.

W. E. ROWE, T. F. BALL and R. L. SUMWALT have organized the firm of ROWE, BALL & SUMWALT, INC., as consulting engineers, Columbia, S. C., being respectively president, vice-president, and secretary-treasurer. The firm is prepared to serve in either a consulting or designing capacity. Mr. Rowe has had extensive experience in municipal, hydraulic and structural engineering, Mr. Ball in electrical engineering and hydro-electric developments, and Mr. Sumwalt in structural and highway engineering and in the promotion of industrial enterprises.

G. W. HOFFMAN, who has been a senior inspector in the Pennsylvania State Department of Highways, has entered the service of the United States Bureau of Public Roads and will be located at Denver, Colo., as a junior highway engineer.

J. G. THOMAS has relinquished his work in the Michigan State Highway Department to go into the valuation department of the Pere Marquette R.R. in the Detroit office.

HENRY H. WILSON, of Harrisburg, Pa., and WINSTON BROTHERS Co., of Minneapolis, Minn., are now associated under the name of Winston Bros. Co. & H. H. Wilson, with office at Harrisburg, Pa. Winston Bros. Co. has been in general construction for more than fifty years, including interest in the construction of more than 8,000 miles of railroad. Mr. Wilson was connected with Winston & Co., Inc., of Kingston, N. Y., and Richmond, Va., for fifteen years as a special partner on construction work. He will continue as a special partner in charge of the crushed stone business of his former associates in construction.

ARTHUR C. SHIELDS, assistant general manager of the Denver & Rio Grande Western R.R., relieves I. H. LUKE as general manager April 1. Mr. Luke retires after fifty years of railroad service. Mr. Shields went to the Rio Grande in August, 1923, to a new office, that of engineer, maintenance-of-way, created for him. After about two and one-half years in that office he was advanced to the position of assistant general manager and now he is appointed general manager. Mr. Shields started his railroad career with the Rock Island, about twenty years ago.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

BUILDING OFFICIALS CONFERENCE, Portland, Ore.; Annual Meeting, Chicago, April 26-29.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Philadelphia Section of the American Society of Civil Engineers met in City Hall, Philadelphia, on the evening of March 25. Seven addresses were given on "The Improvement of Our Water Resources Through the Co-operation of the State, Municipalities and Industries." Besides officials of Philadelphia and Pennsylvania, the speakers included Harrison P. Eddy, consulting engineer, Boston; Charles A. Jobson, manager Technical Department, New York & Pennsylvania Co., Lock Haven; and Arch F. Jones, chief counsel, Elk Tanning Co., Ridgeway.

The Engineers' Society of St. Paul at a luncheon meeting Feb. 28 was addressed by Ralph Budd, president of the Great Northern Railway Co., on the subject of the "Proposed Unification of the Northern Pacific, Great Northern, and the Spokane, Portland & Seattle Railways, with Unified Control of Affiliated Companies." The feature of the society's regular monthly meeting March 14 was a moving picture on "Building New York's Newest Subway," the film being sent by the Du Pont Co.

The New York Section of the American Water Works Association will hold its next meeting May 5 and 6 at Oswego, N. Y. E. D. Case, of The Pitometer Co., 50 Church St., New York City, is secretary.

Obituary

A. S. GOING, terminal engineer of the Canadian National Ry. at Montreal, Que., died in that city March 21 at the age of 67 years. Mr. Going was formerly engineer of construction of the old Grank Trunk Ry. and had been connected with that company since 1907. Prior to that he was employed as location engineer by several railroads notably the Minneapolis & St. Louis, the Northern Pacific and the Grand Trunk Pacific.

THOMAS H. MATHER, chief engineer of the Grade Crossing Commission of Syracuse, N. Y., died March 23 at his home in that city, at the age of 67 years. Mr. Mather was born in Glasgow, Scotland, where he received his engineering education and was connected for five years with an engineering firm. He came to the United States in 1882 and was engaged on construction and trackwork and in office work for the Canadian Pacific Ry. with intervening periods of work on a reservoir in New Mexico, an underground railway in Glasgow, with a mining corporation, and in inspection of railroad bridges in the southern part of the United States. He went to Syracuse in 1892 and organized the firm of Mather & Allen, and was engaged in sewer, paving and other engineering work in the city. In 1916 he was elected commissioner of public works in Syracuse. At the time of the World War, Mr. Mather was in charge of construction of docks as civilian attaché, supervising engineer in the ordnance department and superintendent of utilities. Later, he became city engineer of Syracuse, then chief engineer of the grade crossing commission.

E. A. W. HAMMATT, consulting engineer, died March 18 at his home in South Orleans, Mass., aged 72 years. He was a graduate of Massachusetts Institute of Technology, and in former years was engaged on the construction of the waterworks plants at Marlboro, Hudson, and Belmont, Mass., and Gardiner, Maine.

JOSEPH E. SNELL, consulting engineer, Newark, N. J., died March 21 at his home in that city, at the age of 68 years. Mr. Snell was known for his work on water-front construction. He was superintendent of building and docks for the Lackawanna R.R. for 28 years. During the past fifteen years he had been employed by Henry Steers, Inc., contracting engineers, New York City, by the Hoboken Land Improvement Co., and by the Ellermans Wilson Line, Inc., of New York.

CHARLES M. GEIGER, civil engineer in the employ of the city of Denver, Colo., died March 23 of pneumonia, aged 67 years. In early years Mr. Geiger was district highway engineer for the Wyoming State Highway Department and laid out portions of the Union Pacific and the Denver & Rio Grande Western railroads.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Trade-ins Discussed at Meeting of Equipment Distributors

At the annual meeting of the Associated Equipment Distributors, Chicago, January 8, J. W. Bartholow, of the J. W. Bartholow Co., Dallas, Tex., talked on the subject of trade-ins.

Mr. Bartholow's remarks are summarized below:

"(1). In our opinion it is necessary at various times both to buy and sell used equipment.

"(2). In fixing a price on used equipment, the dealer should never give more than the article is worth. While this would seem to be a corollary, the temptation to exceed such a value has been so great that the dealer is cautioned that courage must be used to carry this out in practice.

"(3). In fixing values preference should be given to equipment of the brand sold new by the dealer.

"(4). In no case should the dealer allow his business to become the clearing house for cheap machinery once junked and with which the user became dissatisfied soon after its purchase.

"(5). The amount and extent to which a dealer should engage in trade-ins depends entirely on his indivdual capacity both financially and in the absorption power of the territory in which his business is situated.

"(6). It is very necessary that the whole subject be handled as a purely individual matter for each distributor, rather than as a general matter.

"(7). In our opinion, it is not a business which should be engaged in by the manufacturer except possibly in cases where the manufacturer desires to introduce an entirely new line or design and can therefore afford to take a loss on some trade-ins and charge it to advertising or promotion."

Asphalt Paving Statistics

The Asphalt Association, New York, has compiled the following figures giving total yardages of asphalt road and street paving annually from 1910 to 1926.

ASPHALT PAVING BY YEARS

	Sq.Yds.		Sq.Yds.
1910	18,800,000	1919	55,700,000
1911	23,300,000	1920	73,800,000
1912	30,300,000	1921	71,200,000
1913	39,100,000	1922	89,900,000
1914	36,900,000	1923	108,000,000
1915	50,400,000	1924	124,800,000
1916	59,000,000	1925	133,500,000
1917	64,000,000	1926	140,000,000
1918	52,600,000		

New England Road Show

The third annual outdoor Road Show, under the auspices of the Massachusetts Highway Association, will be held this year May 11 and 12, at Cottage Farm Bridge and Memorial Drive, Boston, Mass. The show has the co-operation of all of the New England highway associations, thus making it an all-New England Road Show. In 1926 it is said some 10,000 people visited the show. John A. Gaffey, Massachusetts Highway Association, is director general of the show, and John M. McCarthy, secretary. Directors are F. W. Mattheis, Hedge & Mattheis Co.; C. F. Reuter, Mead-Morrison Mfg. Co.; B. J. Surrett, Dyar Sales & Machinery Co.; James J. Tobin, Granite Paving Block Association; L. F. C. Bryant, Buffalo-Pitts Steam Roller Co.; Fred D. Richardson, superintendent of streets, Brookline, Mass., and F. C. Pillsbury, Massachusetts State Engineering Department.

Award to Be Made for Emblem of Power Transmission

An award of $250, to be announced at the National Industrial Advertisers Association convention, in Cleveland, June 15, has recently been made by the Power Transmission Association, Drexel Building, Philadelphia, for the best slogan-emblem design for the association.

The wording should typify the objective of the association in the briefest possible words, with a striking action design. Ideas are wanted, not necessarily a finished drawing. The object of the association is to determine and foster the right drive or use of mechanical power transmission for any given installation by means of belts, pulleys, shafting, gears, clutches or chains.

Business Notes

W. J. JOHNSON, Pittsburgh, Pa., has left the Lidgerwood Mfg. Co. and will hereafter devote his time to his private interests. Mr. Johnson is president of the Allegheny Equipment Corp. of Pittsburgh and is associated in an active capacity with that company at the present time.

LE ROI CO., Milwaukee, Wis., which about the first of the year took over the business formerly conducted by the Beaver Mfg. Co., is now in a position to manufacture gasoline engines ranging in horsepower from 3 to 160. The Beaver engines are solely intended for heavy duty and have a horsepower range of 40 to 160, made in four and six-cylinder sizes.

QUINN STONE & ORE CO., LTD., Cleveland, Ohio, announces that it will be in a position to ship, beginning May 1, from its quarry and plant at Fort William, Ontario, all grades and sizes of Lake Superior trap rock. This rock can be delivered to any of the Great Lake ports. Modern equipment will permit carefully classified products ranging in size from 3 in. down. The capacity of the plant is 250 tons per hour.

W. W. FITZPATRICK, formerly general sales manager, Rawls Mfg. Co., Chicago, manufacturers of railway and highway mowers, has become associated with the Nordberg Mfg. Co., Milwaukee, and will devote his entire time to the sale of the company's railway track machine.

ROGER BIRDSELL has recently been appointed sales manager of the Racine Radiator Co., Racine, Wis., taking the place of F. M. Young, former vice-president and general manager, who has left the company.

E. C. HINGSTON and J. W. O'BRIEN have formed the firm of E. C. Hingston Co., 434 Plymouth Court, Chicago, Ill., for the purpose of carrying on a construction equipment and sales engineering business. Mr. O'Brien was formerly with the Chicago Warehouse Sales Co. and Mr. Hingston with the Bucyrus Co. and for the last five years in private consulting and designing practice.

LINK-BELT CO., Chicago, announces the opening of a new branch sales office in Birmingham, Ala., March 6. W. H. Norton, for many years connected with the company's Chicago sales department, will assume managership of the new territory.

NATIONAL FIRE PROOFING CO., Pittsburgh, announces that Sidney F. Heckert has been elected managing director of the company. Mr. Heckert is president of the Pennsylvania state association of the American Institute of Architects and past president of the Pittsburgh Chapter of the Institute. Mr. Heckert was formerly chairman of the Board of Directors and the new position of managing director is a newly created office.

ARTHUR NICOLAUS, advertising manager, The Heil Co., Milwaukee, died quite suddenly March 9, following an attack of pneumonia lasting only 24 hours. Mr. Nicolaus joined the Heil organization in January, 1922, following his graduation from the Milwaukee Normal School of Journalism. He next attended Marquette University, at the same time working for the Heil Co. Upon his graduation last spring he became advertising manager of the company.

New Developments

New 3-Ton Truck for Contractors

The Indiana Truck Corporation, Marion, Ind., has recently announced a new model 3-ton truck. The distinctive feature of the truck is that it contains very few parts, it being claimed that the entire motor can be taken down in 1 hr. The motor develops 60 hp. The frame is built especially strong, being made of a pressed steel channel section

of ⅜-in. stock 7 in. high with a 3-in. flange. This special steel is claimed to have an elastic limit of 65,000 lb. A two-range multiple speed transmission gives seven different speeds forward and two in reverse. The two sets of speeds are brought into action by a

special hand lever which moves forward for the high set of speeds and backward for the low set. The desired speed of the selected set is secured in the usual manner by the regular shifting lever.

Bucket Capacity of Shovel Increased to 1⅛ Cu.Yd.

The type DC motor operated shovel, manufactured by the Industrial Works, Bay City, Mich., has recently been improved by substituting a 1¼ cu.yd. shovel with necessary increases in

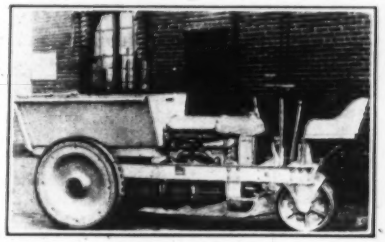
power capacity over that necessary for its former ¾ cu.yd. bucket. On this shovel it is said that a new design of self cleaning driving gears has also been installed. The machine is rated as handling 15 tons as a crane and a 1 cu.yd. dragline bucket.

New All-Purpose Shovel-Crane Announced in ½-Yd. Capacity

A ½-yd. combination shovel, crane, dragline, ditcher, skimmer and backfiller has been announced by the General Excavator Co., Marion, Ohio, which company was recently organized and purchased the business of the Fairbanks Steam Shovel Co., Marion, Ohio. The power unit on the new machine is either a gasoline engine or electric motor, the gasoline engine being rated at 45 hp. and 1,000 r.p.m. The machine is full revolving, mounted upon crawler treads. It is said that 90 per cent of the castings are of cast alloy steel and that all operating gears have machine cut teeth. All booms for the various operations are interchangeable and conversion to any one of the above uses can be made in the field without adding any operating or hoisting mechanism. The bed is a single steel casting upon which all the operating machinery is carried. An inclosed steel cab is standard equipment.

Fordson Truck Designed for Short Haulage Purposes

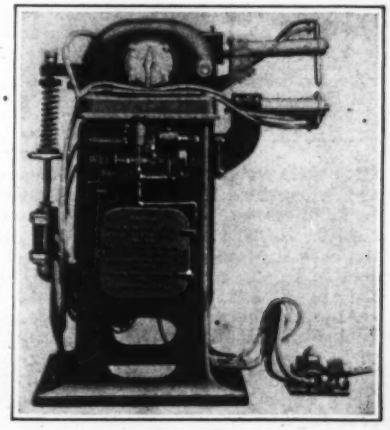
The illustration shows a truck built around a Fordson power plant by the Wehr Co., Milwaukee, Wis. Advantages are claimed to be mobility, ease of maneuvering, quick-loading and dumping. The dumping lever within



easy reach of the operator tilts the body forward. The rear wheel is cast semi-steel fitted with a 24x7 in. solid rubber tire and Timken bearings. The drive wheels on the front accommodate 5, 6, 7, 8 or 10 in. tires. The truck has a wheel base of 86 in., length overall 11 ft. 4 in. and width overall 50 in.; the turning radius is 7 ft. 4 in. The body is the gravity type, 62 in. long by 53 in. wide at the top and 27 in. wide at the bottom; the depth is 21 in. The capacity is one yard. The total weight equipped with one yard body is 300 lb. The unit will handle 6,000 lb. at speeds from 1¾ to 12 m.p.h.

Air-Operated Spot Welder Produces Uniform Welds

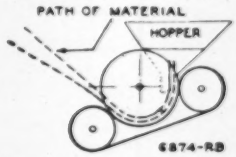
An air-operated spot welder has recently been developed by the Gibb Welding Machines Co., Bay City, Mich., which it is claimed insures uniformity in heat, pressure and time resulting in



a consequent uniformity in welds. On hand or foot-operated spot welders, although the heat and pressure usually remain constant, the time element is a variable factor. This new machine is claimed to eliminate this disadvantage since the operation by air is almost instantaneous. Very slight pressure at the air valve operates the machine. The new welder is best adapted to sheet metal of 18 gage and heavier. On the lighter gages, while the air operation eliminates fatigue accompanying a hand or foot-operated machine, there is no advantage in speed.

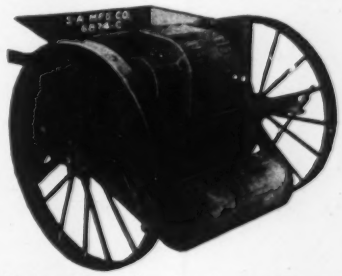
Machine for Loading Bulk Materials Into Box Cars

A centrifugal box-car loader, which is placed in the doorway and projects bulk materials to the far ends of a box car, is a new product of the Stephens-Adamson Mfg. Co., Aurora, Ill. The machine was designed to take the place of such equipment as blowers or belt conveyors. A long belt conveyor is awkward inside of a box car and it is claimed that a short one will not impart the necessary velocity to the ma-



terial. It was found that by carrying the belt travel on a curve that a large amount of additional traction is secured by centrifugal force. A proper projecting speed is thus obtained with this new machine by a belt length of 3 ft.

The loader consists of a motor, a conveyor belt, two pulleys, a shaft with a flat disk at each end which causes the

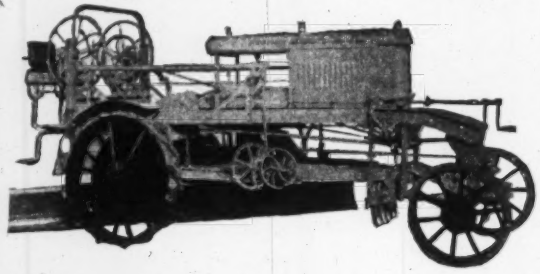


belt to run in its circular path, and a loading hopper. All are mounted on a steel frame with truck wheels and handles and the equipment is little larger than an ordinary wheelbarrow. The material is projected in a setady stream and the angle of discharge may be adjusted. The top of the loading hopper is 2 ft. 10 in. above the floor.

Power Grader Built for Light Grading and Maintenance

A power road maintainer with a straight reversible 12-ft. blade and scarifier is a new product of the Avery Power Machinery Co., Peoria, Ill. It is designed and built for maintenance and light grading alone and is a one-man machine. For maintenance work the blade is located midway between

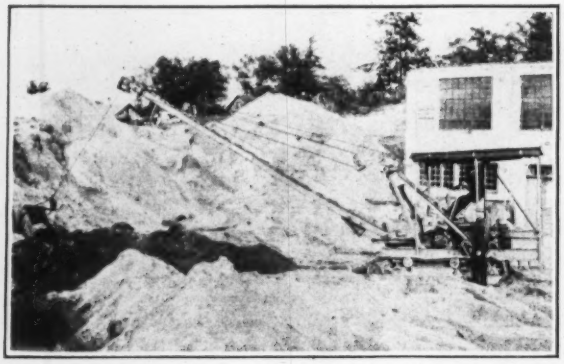
the front and rear wheels, while for grading work it is placed diagonally between the rear wheels, in which case the drivers and heavy rear end of the machine absorb all the end thrust from the blade which aids in holding the machine to its course in heavy cutting. Frame distortion is claimed to be prevented by applying the blade pressure at four different points. The machine will turn in a 28-ft. circle. Either solid rubber or steel tire equipment is supplied. The power unit is a 4-cylinder Waukesha engine.



Excavator Improved by Dragline and Backfiller Attachments

The excavator made by the Insley Mfg. Co., Indianapolis, is now offered with two new attachments, a dragline and a back-filler, both of which are interchangeable with the other attachments of shovel, skimmer scoop, pull shovel and crane furnished for the same machine. A 30-ft. boom with fairleads is used with the dragline; it is the same boom that is used with the crane. The dragline bucket has ½-cu.yd. capacity. The new backfiller has a telescopic boom having a range of 30 to 40 ft. as a standard and with the addition of a 10-ft. intermediate section, the range can be increased from 40 to 50 ft.

In addition to these new attachments, the manufacturers are making a six-wheel trailer for rapid transportation of the machine from job to job. It is furnished with 7-in. solid rubber tires and can be furnished with oversize tires if desired.



New Head for Vertical Lift Pump Is Lighter in Weight

A new type of head for vertical lift pumps such as are used in railway service is being made by the Layne & Bowler Mfg. Co. of Memphis, Tenn. It is known as the top drive head. The advantage of this new type of head is a material reduction in the weight by elimination of a separate motor frame, as the discharge ell in the above-ground discharge pipe serves as a motor stand also. Headroom is reduced by placing thrust and radial bearings in the motor. At the top of the motor is placed a combination thrust and radial bearing, and in the bottom of the motor is placed a radial bearing. The underground - discharge types have approximately the same weight as the above-ground type but with a further reduction in headroom. All types are equipped with a high pressure stuffing box, capable of withstanding heads up to 150 ft. above ground.

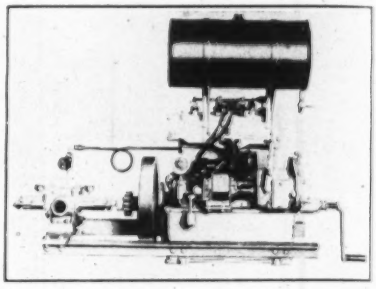
Two other important improvements have been made on this new pump. The elimination of flexible couplings has been accomplished by the use of a direct-connected drive shaft from the pump drive shaft, running up through and keyed to a hollow shaft in the motor. On top of this drive shaft is a nut to adjust the lateral of the pump. It is protected by an easily removable hood. In the older type it was necessary to unbolt the motor and raise it to adjust the pump lateral.

Stair Tread of Aluminum Alloy Is Light Weight but Durable

Many new uses are being found for aluminum alloys. It is reported that the Pullman Co. is now building sleeping cars with aluminum alloy bodies, The American Car & Foundry Co. has an order for 50 double-deck buses for the Detroit Railways Co. of the same material, and the Cleveland Rys. have just completed in their Harvard shops a double-deck trolley car, all aluminum alloy except the trucks. The American Abrasive Metals Co., New York City, recently adopted an aluminum alloy for use in manufacturing anti-slip treads. This is suitable not only for cars and buses, but also for other uses where lightness in weight is important. These stair treads are also claimed to be immune from stale water corrosion. The treads are a combination of special aluminum alloy used as a matrix and an electric furnace abrasive inserted in the wearing surface. The weight is said to be the same as aluminum, but the alloy has considerably greater strength. The product is known as an Alumalun anti-slip tread. It is claimed to be especially desirable in the highly ornamental locations where a silver white color harmonizes with the surroundings.

High-Pressure Pump and Gasoline Engine Directly Connected

The most recent product developed by the Universal Motor Co., of Oshkosh, Wis., is a high-pressure pumping set as illustrated. It consists of a pump with a capacity of 25 g.p.m. against 300 lb. pressure. The total maximum head is 700 ft. The approximate weight of the set is 325 lb. and it is operated at an engine speed of 1,320 to 1,350 r.p.m. The engine is a comparatively small four-cylinder, four-cycle type of 2⅜-in. bore and 4-in. stroke, equipped with Bosch magneto, Zenith carburetor, and is available with a heavy-gage sheet metal housing.



Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York, April 27-29.

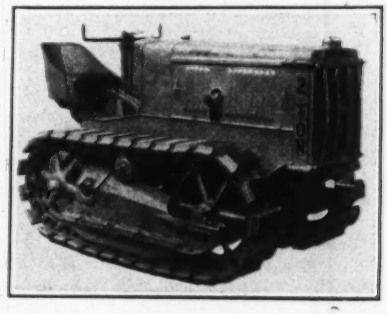
NATIONAL LUMBER MFGRS. ASSOCIATION, Washington, D. C.; Annual meeting, Chicago, April 28-29.

NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

Rubber Shoed Tractor

The accompanying illustration shows a 2 ton Caterpillar tractor equipped with rubber shoes for use in maintaining golf courses, city parks and gravel roads.



Business Side of Construction

Facts and Events That Affect Cost and Volume

More New Offices and Apartments Than in 1926

Hotels Show Decline When Contracts for the First Eleven Weeks This Year Are Compared with Last

DANGER of over-expansion, in almost any section of the country, is apparently greatest in the four types designated as office buildings, apartment houses, hotels, and apartment-hotels.

Adopting a minimum of $150,000 on buildings of the nature described, the total of contracts awarded between Jan. 1 and Mar. 17, 1927 (entire U. S.) is found to be greater than that for the same period last year in the first two and below, in the latter classes.

In office buildings, the gains occurred in New England and the West, exclusive of the Pacific group comprising the states of Idaho, Utah, Nevada, Arizona, Washington, Oregon and California.

Apartment house contracts swept ahead in every section of the country except the South.

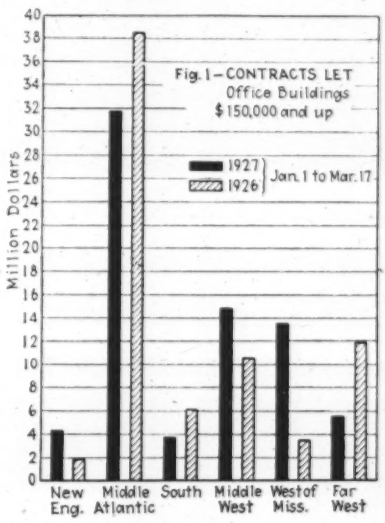
Awards covering hotels registered a substantial increase, compared with the first eleven weeks of 1926, in the Middle West. Elsewhere, marked recessions occurred.

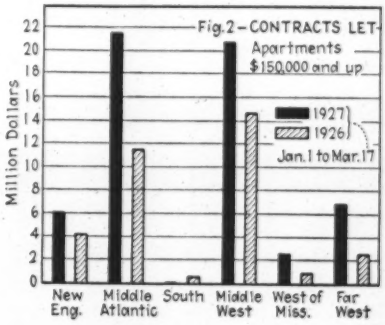
The apartment-hotel class slumped even worse than did that of hotels. The increase noted in Fig. 4, for the section immediately west of the Mississippi, was due entirely to two large jobs.

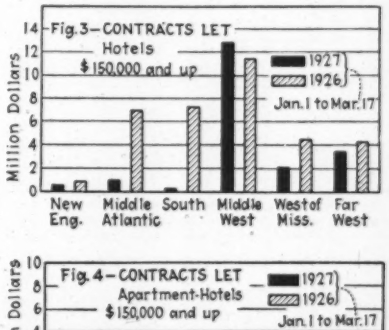
The geographic divisions mentioned in the accompanying diagrams comprise the following states: *New England*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. *Middle Atlantic* — New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia. *South*—Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Kentucky. *Middle West*—Ohio, Indiana, Michigan, Illinois, Wisconsin. *West of the Mississippi*—Iowa, Minnesota, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Montana, Missouri, Arkansas, Texas, Oklahoma, Colorado, New Mexico. *Far West*—Idaho, Utah, Nevada, Arizona, Washington, Oregon, California.

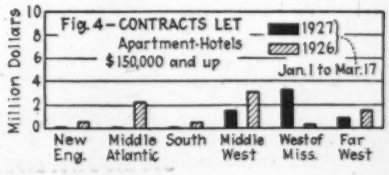
Fig. 5 shows quite clearly the relation of offices and apartments to the other two classes, for the country as a whole. Last year, hotels were ahead of apartments while thus far in 1927, the latter have jumped ahead at a greater rate than any of the other three classes.

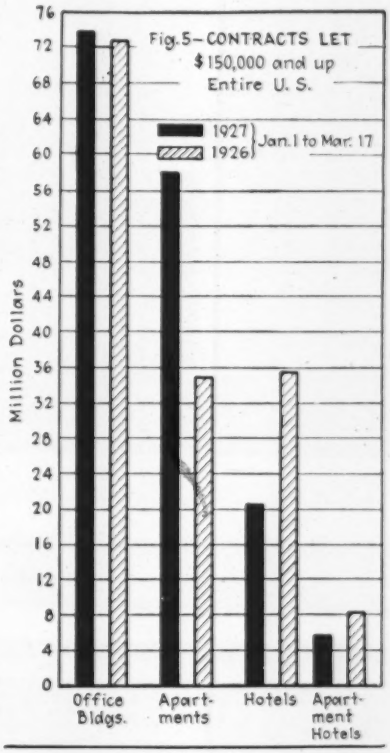
The Middle Atlantic states lead in value of new office buildings and apartments, with the Middle West second obviously because of the fact that the former group contains New York City, while Chicago is situated in the latter. The Middle West, however, runs well ahead of all the other sections in new hotels, on which contracts have been let during the first eleven weeks of 1927. The South shows the smallest volume for three out of the four classes mentioned. The following diagrams show the situation sectionally and for the nation as a whole.











This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding week. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ended	Public Work *	Private Work *	Total Contracts *
Mar. 31, 1927	$19,549	$34,071	$53,620
Mar. 24, 1927	21,013	56,125	77,138
Mar. 25, 1926	17,776	28,126	45,902
Heaviest Week			
1927, Mar. 10	27,407	54,796	82,203
1926, Mar. 11	13,029	73,613	86,642
1925, Sept. 3	16,215	69,424	85,639
Jan. 1 to date			
1927	209,972	451,074	661,046
1926	199,977	401,022	600,999

*000 omitted.

Bond Sales Slump

A sharp decline in state and municipal bond sales took place last month, according to the *Commercial and Financial Chronicle*. The entire amount disposed of was only $63,030,448 compared with $171,232,218 in January and $146,900,816 in February, 1926.

Weekly Construction Market

CHANGES in quotations on the materials listed in the accompanying table are mainly downward, comparing the current week with last. This is contrary to the regular seasonal price movement, since the usual spring construction activities are obviously well under way.

Declines affected structural rivets, ¾-in., and Douglas fir timbers at Seattle; common brick and linseed oil in the New York market; and linseed oil at Minneapolis, which, it is assumed, is the principal center of distribution.

Concreting materials, pine timbers, lime, and clay products hold firmly to current price levels, in the nine districts covered.

Some improvement is noted in demand for railway material, reinforcing bars, and wire products, compared with a week ago.

Steel reinforcing bars, structural shapes (3 to 15 in.), and plates (¼-in. thick and heavier), average $1.90 per 100 lb., at Pittsburgh mills, with a slight cutting-under reported. Plates are evidentally being sold as low as $1.80 per 100 lb., f.o.b. mill, in large tonnages, while the $1.90 figures applies on shipments all the way down to single carload lots in bars and shapes.

Demand for materials, as shown by value of construction contracts, (see p. 549) is ahead of a year ago by a very small margin, while costs are a fraction of one per cent higher than in 1926.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	—3.75	....
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	2.75	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54 25%	41%	42@53 8%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	47.60	42.75	56.00	46.20	48 50	62.00	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl.	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61@63	34.00	56.00	40.50	38.75	33.25	27.00	—23.00	50.00
Lime, finishing, hydrated, ton	18.20	22.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	—19@20	12.00	14.10	12.00	13.75	9@10	15.00	15.00	21.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	.072	.085	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	—80¼	.90¾	1.10	.90¾	—.91½	1.04	.89	1.12	1.05
Common Labor									
Common labor, union, hour	.90⅜	.30	..	90	.....	.50@.55	.60	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	....	.45@.60	40@.45	.50	.....	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor—Cement and concrete laborers' rate, $1.06½; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Mar. 3, the next on Apr. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5⅓ x 8 x 11⅓. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) carlots; shapes, l.c.l.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.125). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.

Unit Prices

For actual prices bid on materials in place at various construction jobs throughout the country, see p. 72-74 of this issue, following Construction News.

On Mar. 1, 1927

E. N.-R. Construction Cost Index Number 208.80

E. N.-R. Construction Volume Index Number 182

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month